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Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

Situation report 146

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Foreword

The present report aims to provide a comprehensive picture of the **pandemic situation of COVID-19** in the EU countries, and to be able to foresee the situation in the next coming days. We provide some figures and tables with several **indexes and indicators** as well as an **Analysis** section that discusses a specific topic related with the pandemic.

As for the predictions, we employ an **empirical model**, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the **evaluation of the quality of control measures made in each state** and a **short-term prediction of trends**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 7-14 days later.

We show an individual report with 8 graphs and a summary table with the main indicators for different countries and regions. We are adjusting the model to **countries and regions** with at least 4 days with more than 100 confirmed cases and a current load over 200 cases.

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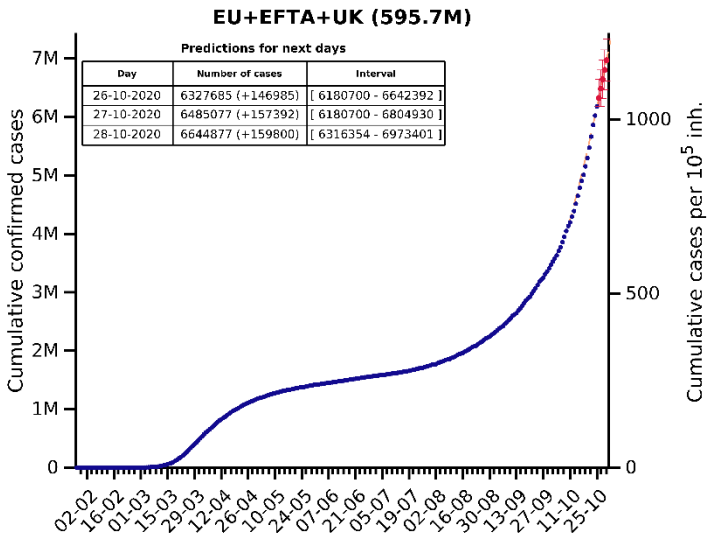
Situation and highlights

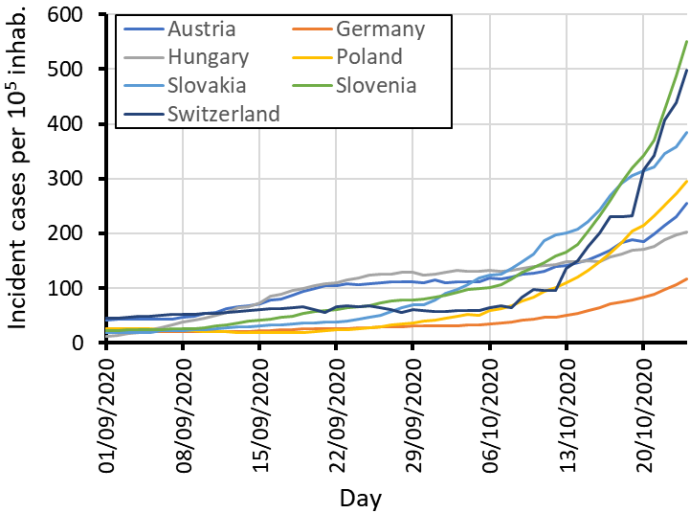
Global situation

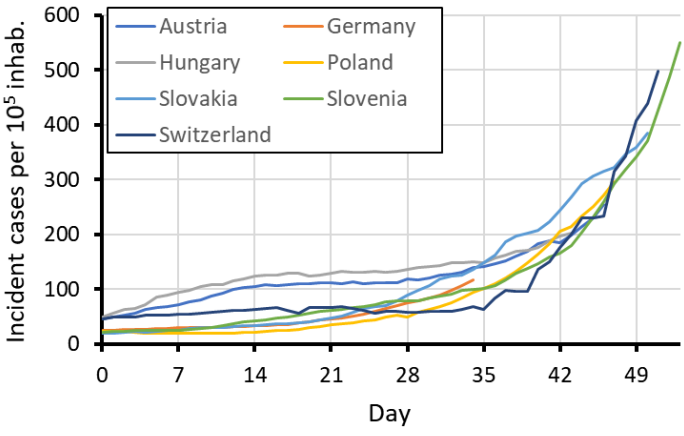
A few weeks ago, we observed how Spain, France, and the UK were following the same trajectory in the growth of incidence with some weeks one after each other. Today, we repeat the exercise with countries in central Europe. We do not include the Czech Republic in the figures because the difference with other countries is huge. We have countries with quite a different situation, from Germany, with an A14 just over 100 cases per 105 inhabitants, to others with a very complex situation such as Slovenia or Switzerland, with incidences of around 500 cases per 105 inhabitants. We can see that all the trajectories are similar. We have built a figure shifting backward in some countries, using the periods shown in the table (see below). Certainly, some countries start with a higher incidence, but once growth has begun, all trajectories have similar characteristics.

In this second figure, we see for example that Germany is in a much better situation than its neighbouring states. Nevertheless, we also see that, if they fail to slow down the rate of spread (ρt), they will achieve an A14 of 500 cases per 10^5 inh. in two weeks.

We can draw some important conclusions from this observation. If a certain growth occurs starts at a low incidence level, the complex situation will be delayed but cannot be avoided unless measures are taken. Therefore, the criterion for implementing control measures should not be taken as the point at which the epidemiological situation is complex, but to start applying measures once the ρ_t starts increasing in a persistent manner. We need to anticipate the pandemic.







	Austria	Germany	Hungary	Poland	Slovakia	Slovenia	Switzerland
Delay (days)	7	19	10	6	3	0	2

Highlights

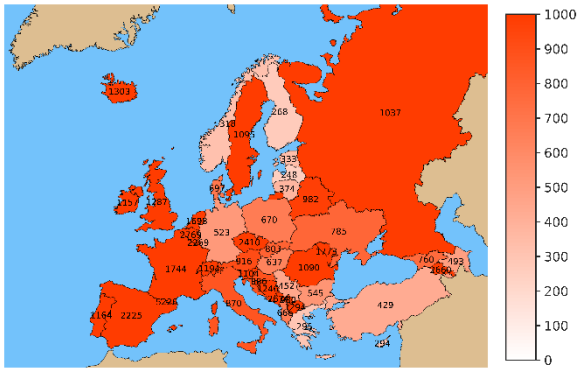
- 14-day cumulative incidence is greater than 1000 cases per 10^5 inh. in Czech Republic (1316) and Belgium (1265). These numbers entail a 1 % of countagious cases among population.
- Luxembourg and Slovenia have lower incidences (774 and 687 respectively) but a high ρ_t that can lead these countries above the 1000 cases in a few days.
- Most of countries show an exponential growth (ρ_t>1). Only Iceland shows a ρ_t under 0.9. Ireland, Finland and Sweden are between 0.9 and 1.
- All countries but Sweden, Finland, Estonia and Norway are at high risk (EPG>100).

Situation and trends per country

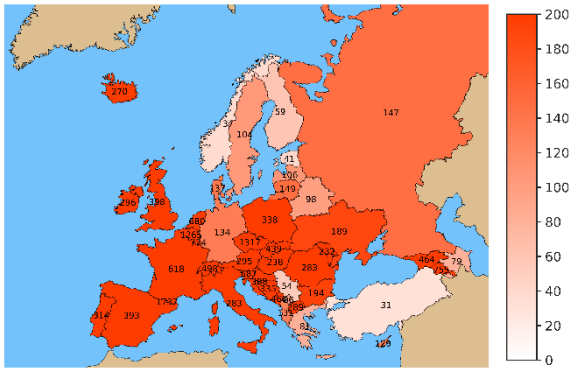
Maps of current situation in EU countries. Colour scale is indicated in each legend.

- Cumulative incidence: total number of reported cases per 100,000 inhabitants
- A_{14}: Cumulative incidence last 14 days per 100,000 inhabitants (active cases)
- ρ_7: Empiric reproduction number
- EPG: Effective Potential Growth ($EPG = A_{14} \cdot \rho_7$)

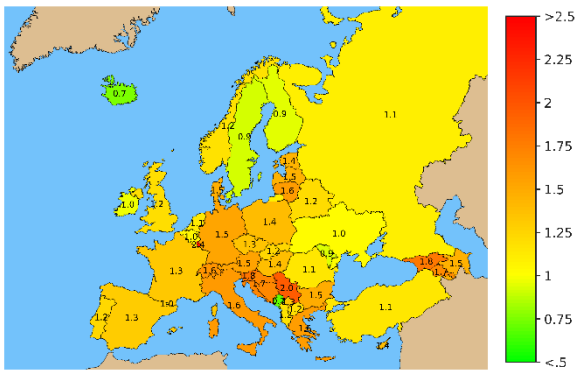
Cumulative incidence



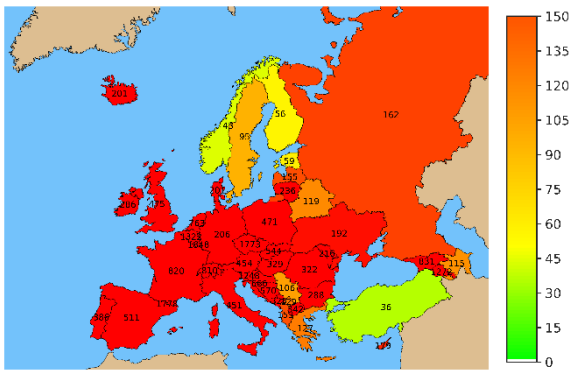
A_{14}



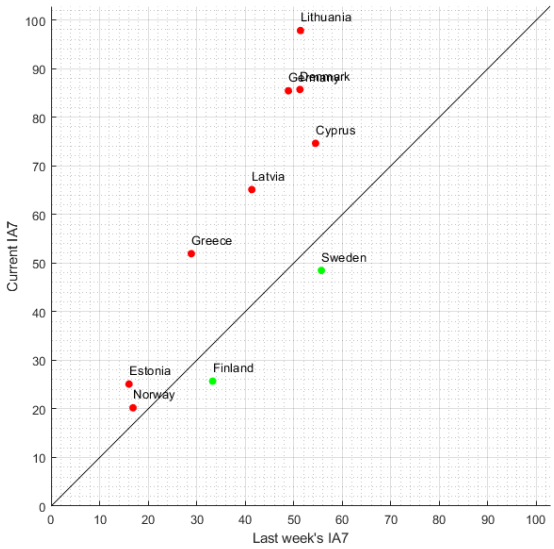
ρ_7

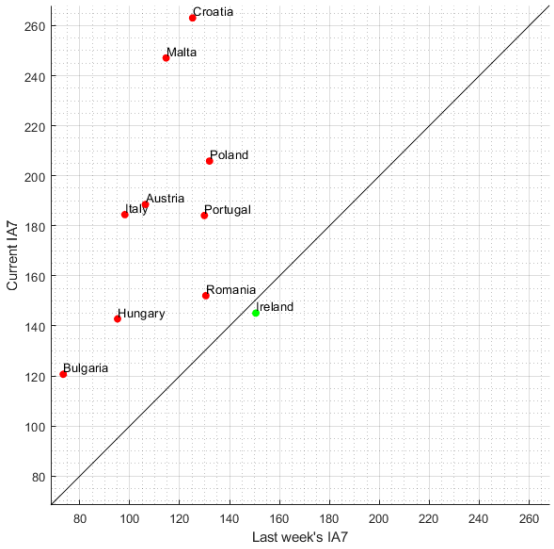


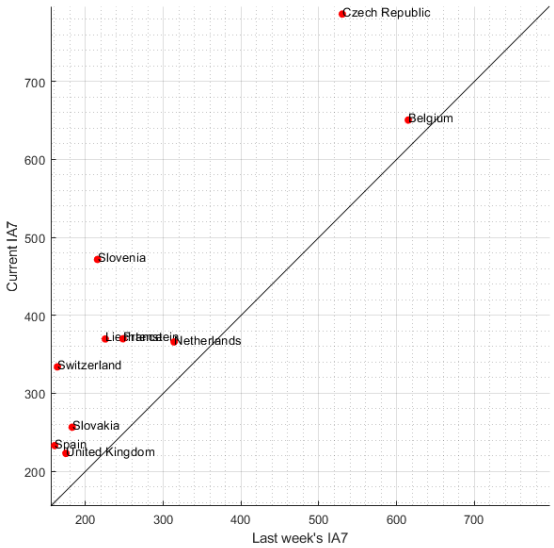
EPG



7-day cumulative incidence trends in EU countries. Current and previous week cumulative incidences by countries. In red, countries where situation has worsened (above the diagonal). In green, countries whose situation has improved (below the diagonal). Axes' scales are adapted to each set of countries.







Tables of current situation in EU countries. Colour scale is indicated in each legend.

Incidence, mortality and epidemiological indexes.

	Reported data						Indexes		
Country	14-day attack rate /10^5 inh.	Active cases (last 14 days)	Attack rate /10^5 inh.	Cumulative cases	Mortality /10^5 inh.	Cumulative deaths	ρ_7 [1]	EPG [2]	Biocom-Cov degree
Czech Republic	1,316.5	140,987	2,410.1	258,097	20.6	2,201	1.35	1,773	9
Belgium	1,265.4	146,653	2,769.2	320,937	93.3	10,810	1.04	1,322	9
Luxembourg	773.8	4,844	2,269.1	14,204	23.2	145	2.39	1,848	9
Slovenia	687.1	14,285	1,103.9	22,950	8.8	183	1.82	1,248	9
Netherlands	679.8	116,475	1,697.9	290,925	41.1	7,036	1.12	763	9
France	618.2	403,533	1,744.2	1,138,507	53.3	34,761	1.33	820	9
Liechtenstein	595.2	227	957.1	365	2.6	1	1.55	921	9
Switzerland	497.9	43,093	1,193.8	103,323	21.7	1,876	1.63	810	9
Slovakia	439.4	23,992	803.0	43,843	2.9	159	1.24	544	9
United Kingdom	397.8	270,084	1,287.2	873,800	66.1	44,896	1.19	475	9
Spain	393.4	185,020	2,224.6	1,046,132	73.9	34,752	1.30	511	9
Croatia	388.3	15,940	886.2	36,380	10.6	437	1.71	666	9
Malta	361.7	1,597	1,216.9	5,373	11.3	50	1.35	490	9
Poland	337.9	127,872	670.3	253,688	11.7	4,438	1.39	471	9
Portugal	314.0	32,022	1,164.0	118,686	22.7	2,316	1.23	386	9
Ireland	295.7	14,600	1,157.0	57,128	38.1	1,882	0.97	286	9
Austria	294.8	26,553	916.4	82,536	10.9	984	1.54	454	9
Romania	282.6	54,365	1,089.8	209,648	33.2	6,391	1.14	322	9
Italy	282.5	170,832	869.6	525,782	61.8	37,338	1.60	451	9
Iceland	270.2	922	1,303.4	4,448	3.2	11	0.74	201	9
Hungary	237.9	22,986	637.3	61,563	15.2	1,472	1.38	329	9
Bulgaria	194.1	13,487	545.3	37,889	15.7	1,094	1.49	288	9
Lithuania	149.2	4,062	374.1	10,184	4.9	134	1.58	236	8
Denmark	137.0	7,934	696.7	40,356	12.1	702	1.47	201	8
Germany	134.3	112,535	522.6	437,866	12.0	10,056	1.53	206	8
Cyprus	129.1	1,559	293.6	3,545	2.1	25	1.39	179	8
Latvia	106.5	2,008	248.0	4,678	3.0	56	1.45	155	8
Sweden	104.2	10,519	1,095.1	110,594	58.7	5,933	0.91	95	7
Greece	80.8	8,424	295.3	30,782	5.5	574	1.58	127	7
Finland	59.0	3,268	268.0	14,848	6.4	353	0.94	56	6
Estonia	41.2	546	332.5	4,411	5.5	73	1.44	59	6
Norway	37.1	2,011	317.9	17,232	5.1	279	1.17	43	5

Colour scale							
>150.0	Worst	Worst	Worst	Worst	Worst	>2.0	>150
0.0	Best	Best	Best	Best	Best	0.0	0

Table of current situation in some EU provinces. Colour scale is indicated in each legend.

	Reported data						Indexes		
Province	14-day attack rate /10^5 inh.	Active cases (last 14 days)	Attack rate /10^5 inh.	Cumulative cases	Mortality /10^5 inh.	Cumulative deaths	ρ_7 [1]	EPG [2]	Biocom-Cov degree
Brussels	1,857.5	22,438	4,072.8	49,200	140.4	1,696	1.34	2,497	9
Prague	1,330.2	16,920	3,188.4	40,557	NA	NA	1.21	1,609	9
North Holland	790.4	22,550	2,070.9	59,083	34.0	971	1.11	876	9
Bern	540.1	5,590	966.5	10,003	10.9	113	1.85	1,000	9
Madrid	435.0	28,888	4,237.0	281,364	150.6	9,998	0.85	369	9
Wien	372.9	7,073	1,469.1	27,869	16.9	320	1.46	544	9
Lisbon	290.6	8,234	1,745.8	49,459	31.7	898	1.21	353	9
Lazio	266.2	15,651	611.3	35,936	19.0	1,116	1.49	397	9
London	264.2	23,676	951.0	85,215	NA	NA	1.34	355	9
Berlin	219.3	8,266	692.3	26,094	6.6	250	1.37	299	9

Colour scale							
>150.0	Worst	Worst	Worst	Worst	Worst	>2.0	>150
0.0	Best	Best	Best	Best	Best	0.0	0

[1] ρ_7 is the average of 7 consecutive ρ, but can still fluctuate. [2] EPG stands for Effective Growth Potential, which is the product of reported cumulative incidence of last 14 days per 10^5 inhabitants by ρ_7 (empiric reproduction number). Biocom-Cov degree is an epidemiological situation scale based on the level of last week's mean daily new cases (https://upcommons.upc.edu/handle/2117/189661, https://upcommons.upc.edu/handle/2117/189808).

Situation of hospitalisations and ICUs in some EU countries. The analysis is done for those countries that report a historical series with current (active) number of patients in hospitals and ICUs[1]. We provide:

- Current active hospitalisations and patients in ICU per 100,000 inhabitants.
- Current absolute number of active hospitalisations and patients in ICU.
- Rate of occupation of curative care hospital beds by Covid-19 patients (data from Eurostat 2018[2]), only for hospitalisations.
- Current rate of occupation with regards to the maximum Covid-19 occupation reached in this pandemic.
- Weekly increase in Covid-19 patients in hospitals and ICUs.

	Hospitalisations					Intensive Care Units			
Country	Active /10^5 inh.	Active (total)	Occupation (Eurostat 2018) (%)	Occupation (historical maximum) (%)	Week-to-week Growth (%)	Active /10^5 inh.	Active (total)	Occupation (historical maximum) (%)	Week-to-week Growth (%)
Belgium	41.6	4827	8.5	83.8	73.5	6.5	757	58.9	63.9
Hungary	26.9	2602	6.2	100.0	30.2	2.4	233	100.0	17.0
France	25.2	16477	8.1	51.0	39.1	4.0	2584	36.6	28.1
Slovenia	25.2	523	6.1	100.0	60.6	3.9	82	100.0	41.2
Italy	23.6	14281	9.1	43.3	56.1	2.1	1284	31.6	52.7
Slovakia	20.5	1117	4.3	100.0	59.8	1.5	82	100.0	110.9
Switzerland	18.2	1578	5.1	70.0	81.6	1.6	142	36.8	73.7
Portugal	16.4	1672	4.9	100.0	32.9	2.4	240	100.0	34.7
Austria	12.7	1142	2.4	83.6	52.1	2.1	188	62.9	37.4

Colour scale
>20%
-20%

Colour scale
>20%
-20%

[1] https://github.com/ec-jrc/COVID-19

[2] https://ec.europa.eu/eurostat/databrowser/view/hlth_rs_bds/default/table?lang=en

Situation and trends in some European regions[3]

Table of current situation in Switzerland by region. Colour scale is indicated in each legend.

	Reported data						Indexes		
Region	14-day attack rate /10^5 inh.	Active cases (last 14 days)	Attack rate /10^5 inh.	Cumulative cases	Mortality /10^5 inh.	Cumulative deaths	ρ_7 (1)	EPG (2)	Biocom-Cov degree
Geneva	1,124.2	5,621	3,079.6	15,398	66.2	331	1.53	1,723	9
Appenzell Innerrhoden	1,037.5	166	1,493.8	239	0.0	0	1.28	1,329	9
Schwyz	960.1	1,469	1,596.7	2,443	29.4	45	1.17	1,124	9
Valais	919.3	3,190	1,956.2	6,788	50.7	176	0.57	527	9
Jura	913.7	667	1,598.6	1,167	20.5	15	0.79	721	9
Vaud	803.4	6,419	2,347.6	18,757	56.2	449	1.55	1,245	9
Appenzell Ausserrhoden	620.0	341	1,016.4	559	10.9	6	1.39	863	9
Zug	610.8	733	1,169.2	1,403	8.3	10	1.26	768	9
Ticino	589.2	2,080	1,696.0	5,987	100.8	356	1.87	1,105	9
Neuchâtel	548.0	970	1,446.9	2,561	53.7	95	1.02	558	9
St. Gallen	545.8	2,827	1,009.8	5,231	9.3	48	1.52	827	9
Bern	540.1	5,590	966.5	10,003	10.9	113	1.85	1,000	9
Lucerne	480.7	1,894	868.0	3,420	6.3	25	1.44	691	9
Uri	425.0	153	930.6	335	19.4	7	1.55	661	9
Glarus	392.5	157	917.5	367	35.0	14	1.11	436	9
Schaffhausen	385.1	285	716.2	530	10.8	8	2.13	819	9
Thurgau	368.8	1,018	704.0	1,943	8.7	24	1.42	524	9
Zurich	359.4	5,531	1,005.9	15,481	10.2	157	0.99	354	9
Aargau	354.4	2,403	806.3	5,467	8.7	59	1.52	538	9
Nidwalden	348.8	150	839.5	361	9.3	4	1.38	480	9
Basel City	346.5	641	1,136.8	2,103	29.2	54	2.01	695	9
Graubünden	321.2	636	968.2	1,917	25.3	50	1.81	580	9
Basel Country	319.9	899	788.3	2,215	13.9	39	1.60	510	9
Obwalden	297.4	113	742.1	282	13.2	5	0.64	189	8
Solothurn	226.8	567	638.4	1,596	7.2	18	1.52	344	9
Fribourg	145.1	3,284	279.5	6,328	5.2	117	1.68	244	8

Colour scale							
>150.0	Worst	Worst	Worst	Worst	Worst	>2.0	>150
0.0	Best	Best	Best	Best	Best	0.0	0

Table of current situation in the Netherlands by region. Colour scale is indicated in each legend.

	Reported data				Indexes		
Region	14-day attack rate /10^5 inh.	Active cases (last 14 days)	Attack rate /10^5 inh.	Cumulative cases	ρ_7 (1)	EPG (2)	Biocom-Cov degree
South Holland	926.5	34,365	2,409.6	89,371	1.20	1,108	9
Utrecht	864.6	11,300	2,034.0	26,584	1.09	944	9
North Holland	790.4	22,550	2,070.9	59,083	1.11	876	9
North Brabant	735.3	18,713	1,766.8	44,964	1.13	833	9
Overijssel	691.2	7,990	1,409.9	16,298	1.31	906	9
Limburg	572.4	5,003	1,568.5	13,709	1.22	698	9
Flevoland	526.2	2,226	1,290.5	5,459	1.23	650	9
Gelderland	515.1	10,673	1,358.9	28,157	1.06	545	9
Drenthe	438.8	2,159	927.0	4,561	0.92	403	9
Groningen	340.8	1,987	913.9	5,328	0.76	258	9
Friesland	329.8	2,137	800.5	5,187	0.94	309	9
Zeeland	260.1	996	756.1	2,896	0.95	247	9

Colour scale					
>150.0	Worst	Worst	Worst	>2.0	>150
0.0	Best	Best	Best	0.0	0

[3] https://github.com/ec-jrc/COVID-19/tree/master/data-by-region

Table of current situation in Germany by region. Colour scale is indicated in each legend.

	Reported data						Indexes		
Region	14-day attack rate /10^5 inh.	Active cases (last 14 days)	Attack rate /10^5 inh.	Cumulative cases	Mortality /10^5 inh.	Cumulative deaths	ρ_7 [1]	EPG [2]	Biocom-Cov degree
Berlin	219.3	8,266	692.3	26,094	6.6	250	1.37	299	9
Bremen	198.1	1,349	647.1	4,407	9.4	64	1.32	261	9
Nordrhein-Westfalen	174.8	31,337	616.4	110,516	11.3	2,024	1.57	275	9
Hessen	174.6	10,941	524.3	32,852	9.8	611	1.63	284	9
Saarland	166.5	1,648	537.5	5,321	18.1	179	1.23	205	8
Bayern	143.2	18,726	700.1	91,569	21.0	2,746	1.64	235	8
Baden-Württemberg	142.1	15,733	628.7	69,601	17.8	1,972	1.54	218	8
Hamburg	137.0	2,602	606.3	11,514	14.9	283	1.67	228	8
Sachsen	130.3	5,313	335.0	13,653	6.8	278	1.69	221	8
Rheinland-Pfalz	113.7	4,645	405.1	16,549	6.6	268	1.68	191	8
Niedersachsen	97.9	7,814	381.8	30,476	9.2	732	1.31	128	8
Brandenburg	70.4	1,775	258.5	6,515	7.3	184	1.37	96	7
Thüringen	66.8	1,428	274.4	5,863	9.5	203	1.69	113	7
Schleswig Holstein	53.4	1,542	234.5	6,777	5.8	167	2.03	109	7
Sachsen-Anhalt	49.4	1,091	180.9	3,994	3.4	74	1.81	89	6
Mecklenburg-Vorpommern	49.2	792	134.5	2,165	1.3	21	1.38	68	6

Colour scale							
>150.0	Worst	Worst	Worst	Worst	Worst	>2.0	>150
0.0	Best	Best	Best	Best	Best	0.0	0

Table of current situation in the Czech Republic by region. Colour scale is indicated in each legend.

	Reported data				Indexes		
Country	14-day attack rate /10^5 inh.	Active cases (last 14 days)	Attack rate /10^5 inh.	Cumulative cases	ρ_7 [1]	EPG [2]	Biocom-Cov degree
Zlínský	1,830.8	10,802	2,976.9	17,564	1.35	2,465	9
Plzenský	1,612.1	9,431	2,656.9	15,543	1.25	2,018	9
Královéhradecký	1,593.5	8,780	2,353.7	12,969	1.49	2,374	9
Olomoucký	1,516.9	9,587	2,498.4	15,790	1.33	2,010	9
Stredoceský	1,456.5	18,571	2,798.4	35,680	1.35	1,965	9
Jihoceský	1,414.8	9,083	2,273.5	14,596	1.43	2,017	9
Liberecký	1,388.0	6,135	2,358.1	10,423	1.33	1,846	9
Prague	1,330.2	16,920	3,188.4	40,557	1.21	1,609	9
Vysocina	1,280.3	6,568	2,275.6	11,674	1.20	1,536	9
Pardubický	1,210.8	6,296	2,086.9	10,852	1.47	1,777	9
Jihomoravský	1,136.2	13,498	2,057.4	24,442	1.35	1,535	9
Moravskoslezský	1,091.5	13,131	2,217.4	26,675	1.38	1,509	9
Ústecký	1,083.3	8,991	1,795.4	14,902	1.54	1,665	9
Karlovarský	949.5	2,801	1,739.7	5,132	1.40	1,328	9

Colour scale					
>150.0	Worst	Worst	Worst	>2.0	>150
0.0	Best	Best	Best	0.0	0

Situation and trends in other countries

	Reported data						Indexes		
Country	14-day attack rate /10^5 inh.	Active cases (last 14 days)	Attack rate /10^5 inh.	Cumulative cases	Mortality /10^5 inh.	Cumulative deaths	ρ_7 [1]	EPG [2]	Biocom-Cov degree
Argentina	434.5	196,383	2,413.0	1,090,576	63.9	28,896	1.04	450	9
United States of America	263.9	873,621	2,609.1	8,636,165	68.0	225,230	1.14	302	9
Israel	211.7	18,320	3,583.2	310,148	27.7	2,397	0.64	135	8
Colombia	205.5	104,569	1,996.5	1,015,885	59.3	30,154	1.14	234	9
Ukraine	188.5	82,455	785.4	343,489	14.6	6,391	1.02	192	8
Russia	147.4	215,159	1,037.4	1,513,877	17.9	26,050	1.10	162	8
Brazil	140.7	299,146	2,537.7	5,394,128	73.9	157,134	1.05	147	8
Iraq	122.8	49,377	1,123.0	451,707	26.4	10,623	1.02	125	8
Peru	119.3	39,344	2,695.4	888,715	103.6	34,149	1.04	124	8
Qatar	110.5	3,185	4,552.8	131,170	8.0	230	1.16	129	8
Chile	108.2	20,692	2,626.4	502,063	72.9	13,944	1.02	110	7
Canada	100.6	37,987	572.6	216,104	26.4	9,946	0.96	97	7
Belarus	98.3	9,289	982.3	92,823	10.1	957	1.21	119	7
Ecuador	82.8	14,602	916.1	161,635	71.1	12,553	1.21	100	7
Iran	81.9	68,821	677.3	568,896	38.8	32,616	1.19	97	7
India	58.3	789,421	584.6	7,909,959	8.8	119,014	0.88	51	6
Mexico	45.3	58,417	691.2	891,160	69.0	88,924	2.07	94	6
Philippines	28.0	30,687	337.7	370,028	6.4	6,977	0.82	23	4
Indonesia	20.6	56,263	142.5	389,712	4.9	13,299	0.99	20	4
Saudi Arabia	16.1	5,608	990.6	344,875	15.2	5,296	0.91	15	3
Pakistan	4.4	9,670	148.8	328,602	3.1	6,739	1.18	5	2

Colour scale							
>150.0	Worst	Worst	Worst	Worst	Worst	>2.0	>150
0.0	Best	Best	Best	Best	Best	0.0	0

[1] ρ_7 is the average of 7 consecutive ρ, but can still fluctuate. [2] EPG stands for Effective Growth Potential, which is the product of reported cumulative incidence of last 14 days per 10^5 inhabitants by ρ_7 (empiric reproduction number). Biocom-Cov degree is an epidemiological situation scale based on the level of last week's mean daily new cases (https://upcommons.upc.edu/handle/2117/189661, https://upcommons.upc.edu/handle/2117/189808).

Analysis: On the use of artificial intelligence to improve empiric prediction. A collaboration with Facebook AI (Part II).

In our last assessment, we discussed in detail the important advances that different groups have made in modeling the evolution of the epidemics in the short term, defined as predicting unconditionally the situation one week in advance. We reasoned that the reason behind these improvements has been two-fold:

First: we do know a lot more about the epidemics than in March. Right now, researchers making modeling can be safely confident that this epidemic presents overdispersion, which is when a few infect a lot of people. Researchers can safely establish the ratio of asymptomatics as a function of age. And, they can also impose that infections happen around the first day of symptoms or around 5-7 days of getting infected if one is asymptomatic. The infectivity of kids is small while the infectivity of the 20-40-year-old bracket is probably the peak. The number of free parameters has therefore been reduced a lot. Similarly, an empirical model can properly track evolution in the short-term since it has a lot of information from the past and very different countries.

Second: other things that may affect the evolution of the epidemics are frozen variables in the one-week scale. A frozen variable in modeling refers to features of a problem that might affect its evolution but change very slowly in the time-frame of the prediction. So slowly that they might be considered constant for all purposes and be included in other parameters. For example, if there is a strong dependence of infectivity on temperature or humidity they do not change much in the one-week scale or, if they do, they will do it rather randomly.

As we pointed out in the previous assessment, **the problem is that the government and health officials need more than a week to make any preparation. The typical time-frame they request is three-week, or one-month if possible, evolutions to plan for hospital capacity, legislative frameworks to implement containment measures, and, in general, to have a warning about what lays ahead.**

Recent work indicates that one-month is close to the limit of predictability in this sense that, at this time scale, only different scenarios can be postulated depending, precisely, on mobility patterns, individual responses to health official signaling, and environmental conditions. These estimations and scenarios can be very useful for policy-makers but the need for clear unconditional prediction with a given error bar is key. This request is something that we should take seriously. It is indeed very important to be able to assess if, in three weeks, the number of new cases in a given country is going to be around 1,000, 5,000 or 10,000. The consequences for policymakers are clear.

Given this need, it is a pleasure to announce our collaboration with Facebook Artificial Intelligence (AI) to try to respond to this request. Facebook AI has developed new AI models that can make a forecast for all 3,000 counties in the United States (U.S.) with strong performance compared to other state-of-the-art models. The forecasts are available on the Humanitarian Data Exchange[1], and more information about the effort is published in their Data for Good site[2].

Right now, this predictive power is in the process of evaluation for the U.S. Given the good preliminary performance, Facebook AI and ourselves think that it is very important to assess this predictive power also in Europe. This is the task we will try to fulfill in the following months.

[1] https://data.humdata.org/dataset/fair-covid-dataset?fbclid=IwAR3hjrwOmhoy0rNr2iFrkiUawgLaJ2hKfX4P6nZsq-sHmGs4hczKJ5CAOZ8

[2] https://dataforgood.fb.com/tools/covid-19-forecasts/

However, developing the proper methodology to assess the predictive power of an AI is not the only work that is ahead of us. We also need to study in detail the training methods that need to be applied so that the AI can properly assess the situation in European countries. The fact that the AI could have predictive power in the US does not mean that it can have the same level of prediction in Europe given the strong differences in mobility patterns, legislative behavior, and human response.

To understand this point we should investigate the details of the AI. The technical details of the algorithm have been published in this paper by Facebook AI[3].

The core of the AI is a Neural Relational Autoregressive Network which is trained to infer relations between different time-series that might have an impact on the evolution of the epidemics. In other words, the algorithm takes data from different public sources and aims to find time-varying correlations between the different time series that can be fed into a standard structural empirical model of the epidemics.

However, the core of the prediction is not this AI alone, it is a combination with a structural empirical model which tries to reproduce the raw character of the epidemics if all other variables like temperature, mobility, etc were kept constant, and a method to reduce the huge increase in the dimensionality of the parameters that the relational approach entails. This combination we think might be giving this prediction method an edge compared with other models.

First, the structural model uses different regions and their relations to borrow statistical strength across different geographical areas and thus improve the quality of predictions. Second, the level of the reduction of dimensionality and parameter space is also key. If too many parameters are allowed the possibility of overfitting can increase. In other words, this could lead to only predicting the past very well because parameters are overfit to not fail in the prediction of what was known, but could fail to generalize unobserved days.

From the structure of the algorithm, it is thus clear that training the AI and selecting properly which regions to analyze is key in developing proper forecasts. Furthermore, different training protocols might be needed in training for a U.S. forecast with more than 3,000 counties than in Spain or Italy with 50-100 provinces.

In any case, the analysis and calibration of the structural part of the algorithm and the development of proper training techniques is a major endeavor that we hope will prove fruitful. But, as always, there is no guarantee that this is the case. And yet, even improving forecasts in the two-week time window can mean large differences in the fight against the epidemics, especially if the forecasts are trusted by the general populations since it can help the advancement of measures.

One of the key problems in setting up the political framework for restriction of contacts is that the effects of restrictive measures take 10-15 days to affect the evolution. So, a lot of times, they must be taken way ahead of the situation before hospitals are affected. Convincing people that measures must be taken now because the situation is going to be worse in 14 days can also help a lot in preventing the propagation of the disease.

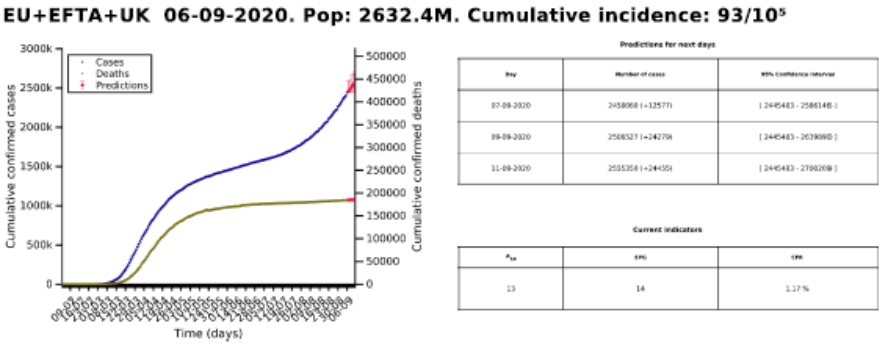
Finally, we conclude this assessment indicating that every Monday we will include the forecast for 50 US states and some selected counties where the big cities of the US are placed. This is the first of these forecasts so that the EC can have a comprehensive view of the situation in the U.S**. So, we want to emphasize that forecasts of the US in this report are done using Facebook AI model.**

As soon as we advance in the calibration and training of the AI we will include a forecast for Europe, first at the two-week time scale, if we think that the forecast can have, at least, a minimum of predictive power.

[3] https://ai.facebook.com/research/publications/neural-relational-autoregression-for-high-resolution-covid-19-forecasting/

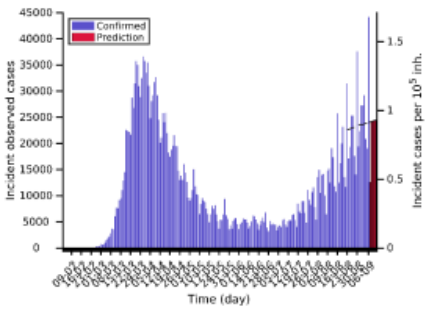
Legend: Countries' reports details

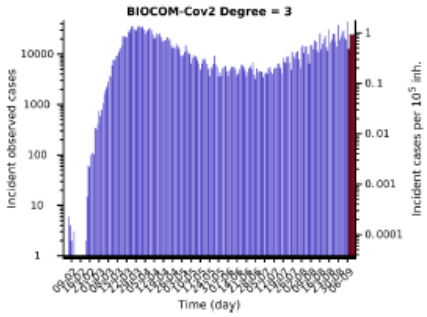
Reported cumulative cases (blue) and deaths (brown), together with predictions (red)



Predictions and indicators

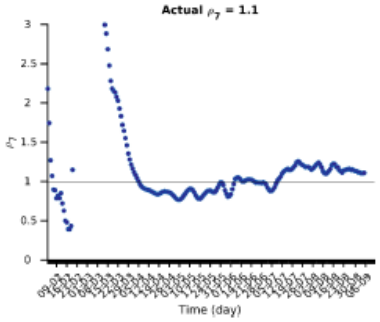
Incident observed cases and predictions.

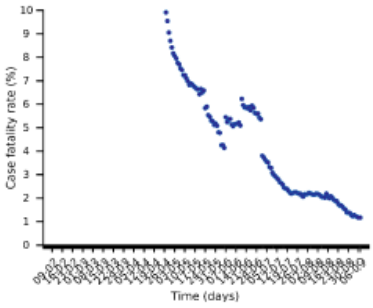




Incident observed cases in a logarithmic scale, with Biocom-Cov degree.

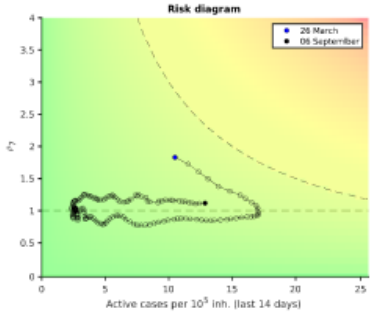
Evolution of empiric reproduction number ρ_7

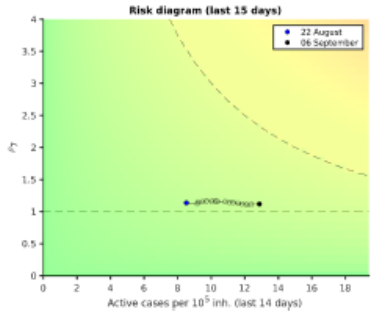




Case fatality rate

Risk diagram

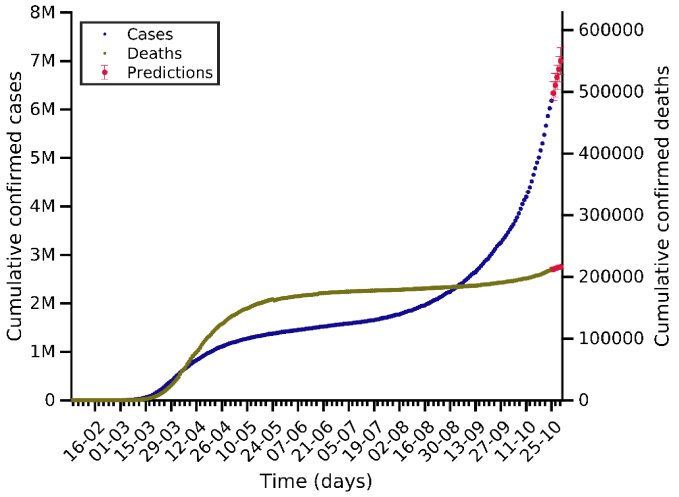




Risk diagram of last 15 days

(1) Analysis and prediction of COVID-19 for EU+EFTA+UK

EU+EFTA+UK 25-10-2020. Pop: 527.9M. Cumulative incidence: 1171/10^5

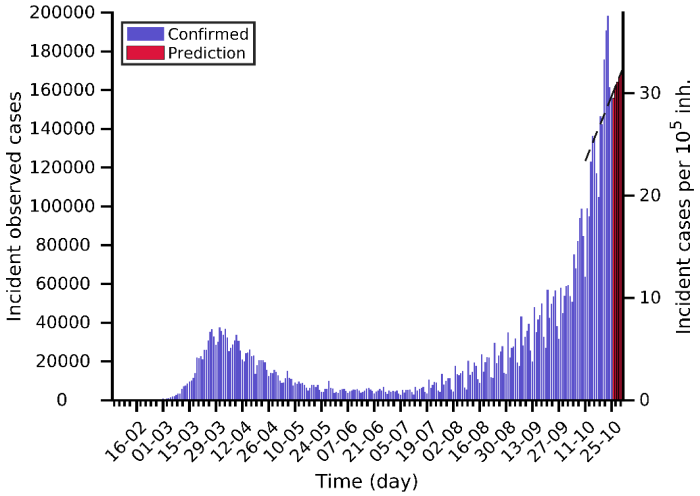


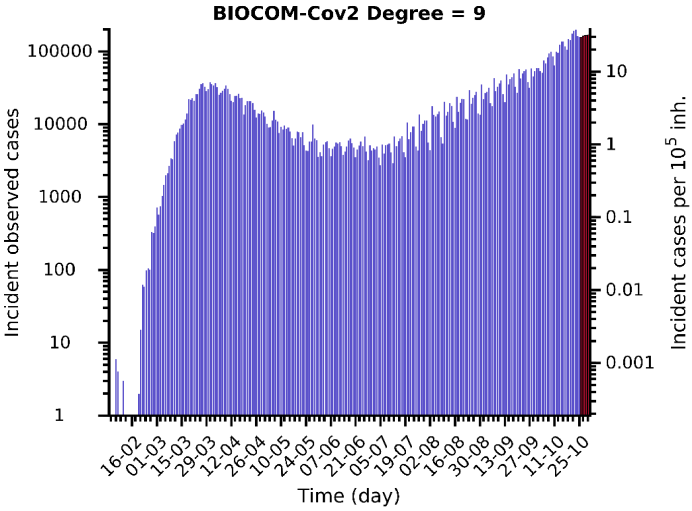
Predictions for next days

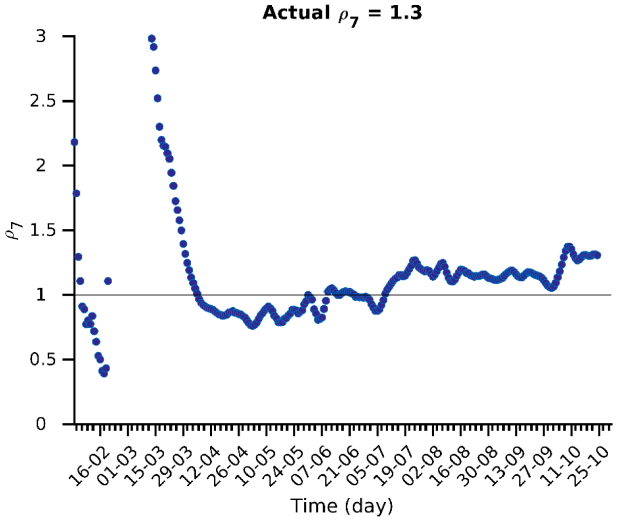
Day	Number of cases	95% Confidence Interval
26-10-2020	6336640 (+155940)	[6180700 - 6575501]
28-10-2020	6662543 (+164134)	[6412343 - 6912743]
30-10-2020	6997872 (+168838)	[6721651 - 7274094]

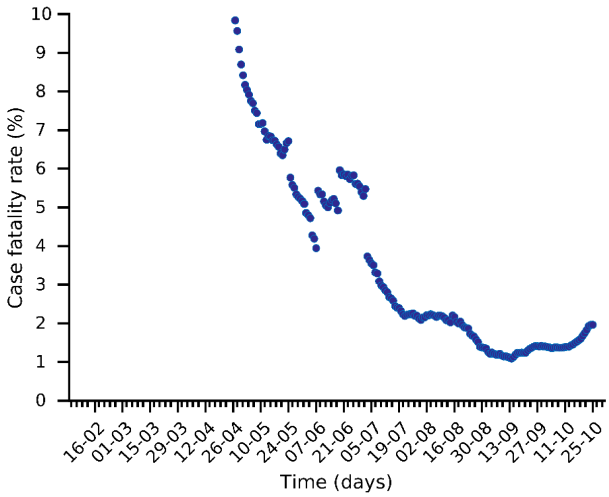
Current indicators

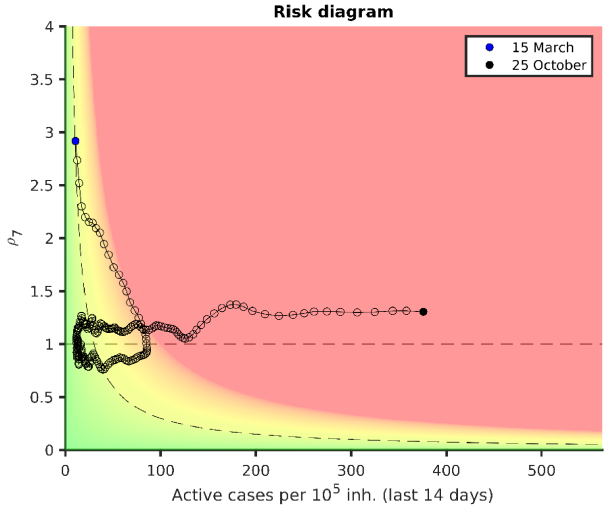
A_{14}	EPG	CFR
376	491	1.96 %

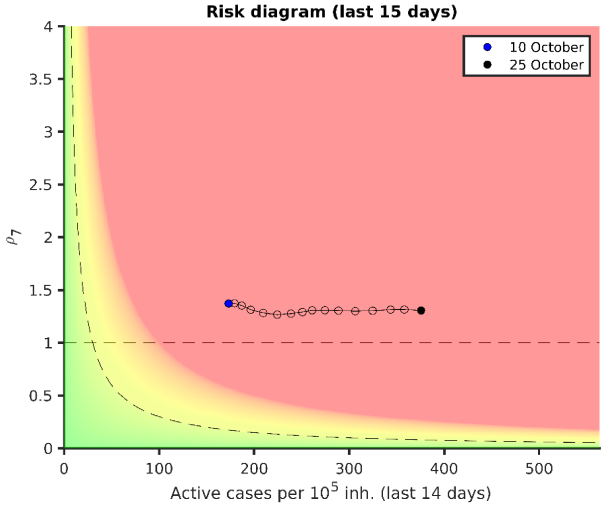




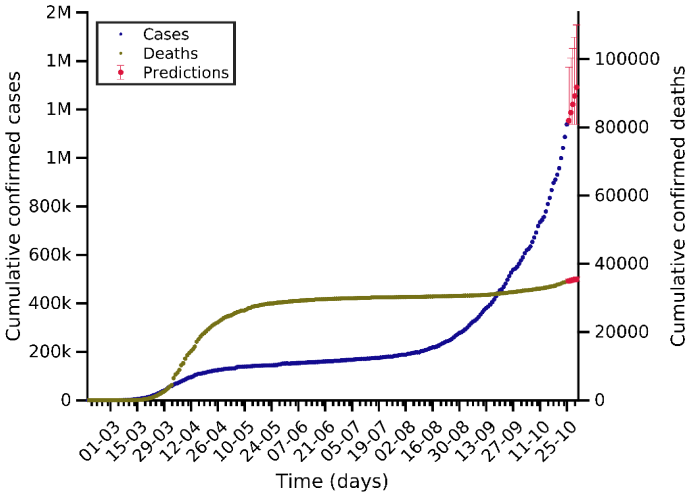








France 25-10-2020. Pop: 65.3M. Cumulative incidence: 1744/10^5

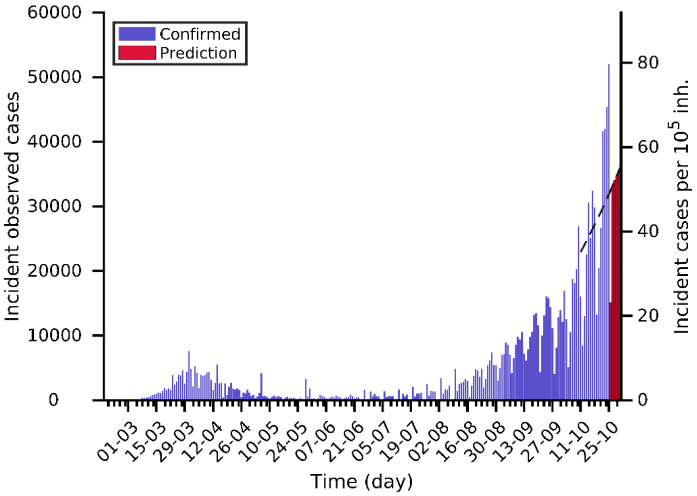


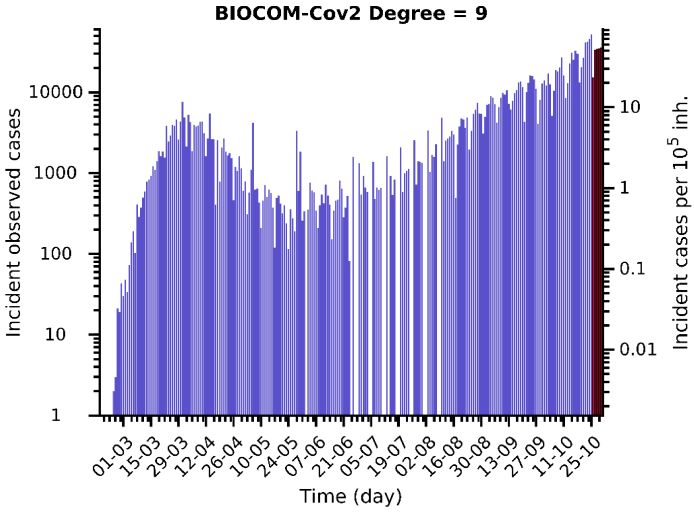
Predictions for next days

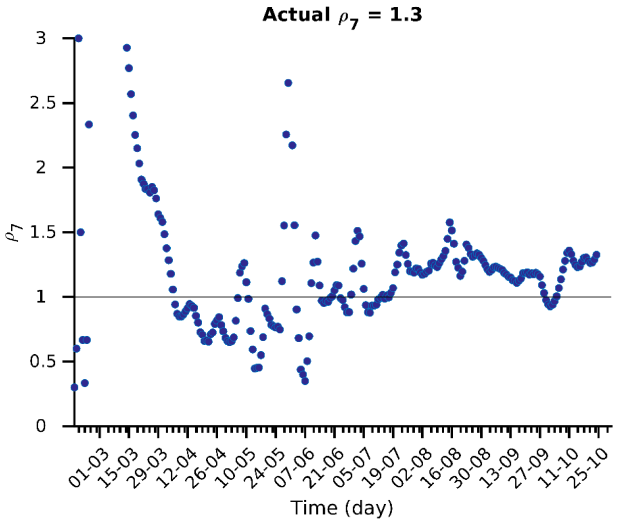
Day	Number of cases	95% Confidence Interval
26-10-2020	1153602 (+15095)	[1138507 - 1374067]
28-10-2020	1220942 (+34034)	[1138507 - 1452513]
30-10-2020	1291230 (+35517)	[1138507 - 1548946]

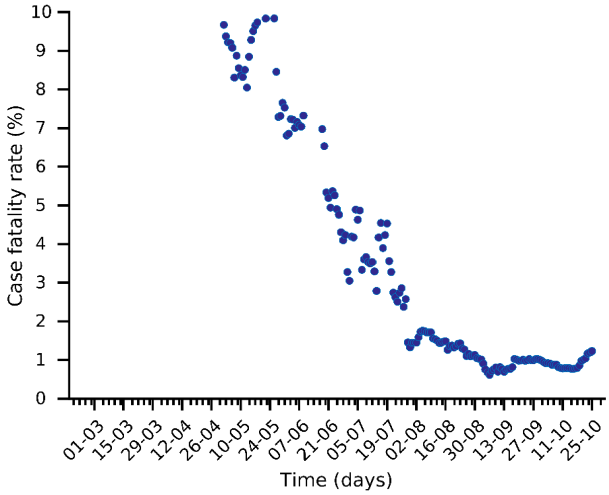
Current indicators

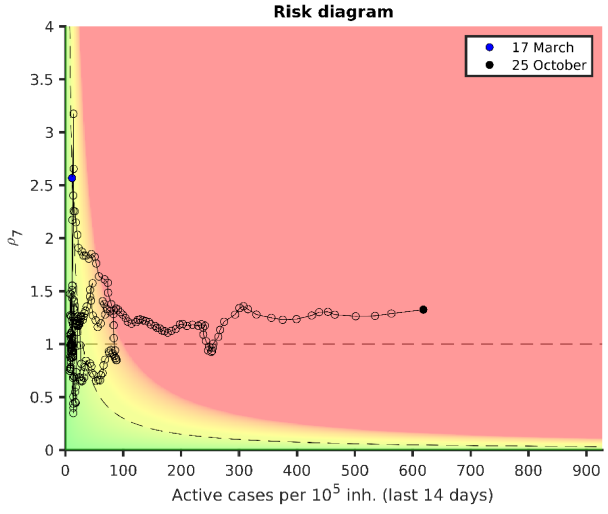
A_{14}	EPG	CFR
618	820	1.23 %

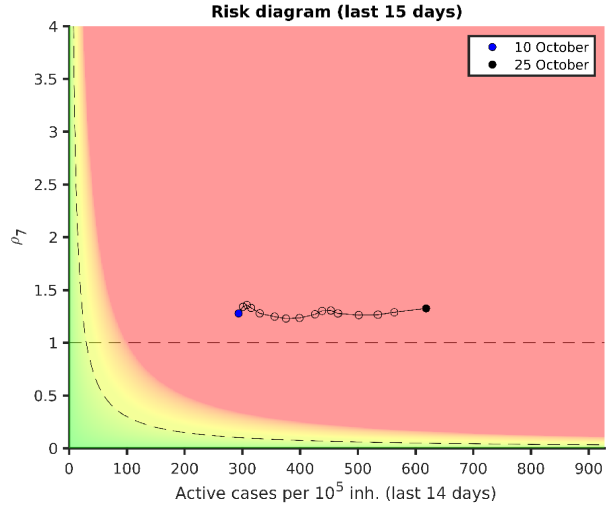




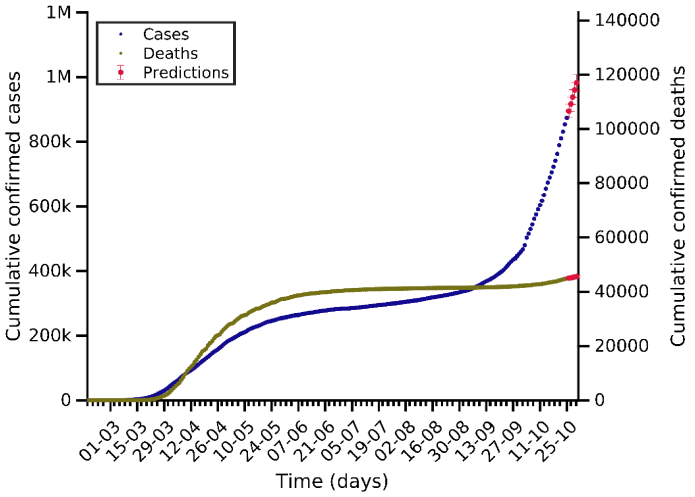








UK 25-10-2020. Pop: 67.9M. Cumulative incidence: 1287/10⁵

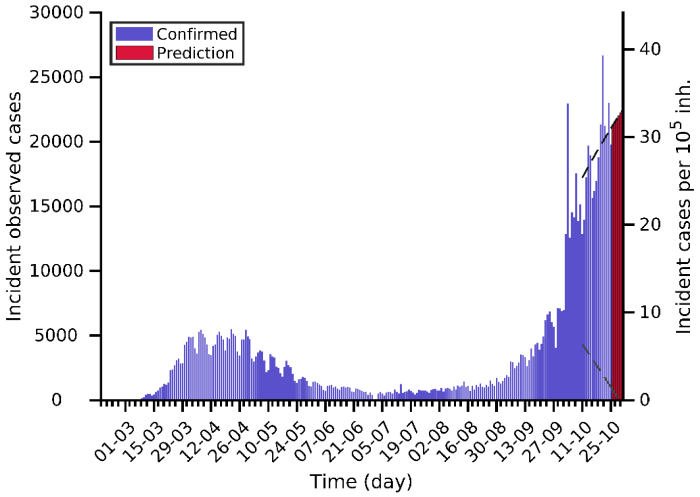


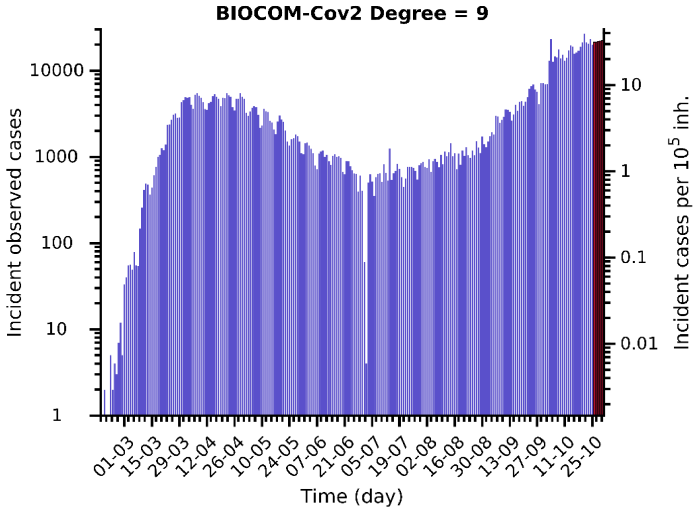
Predictions for next days

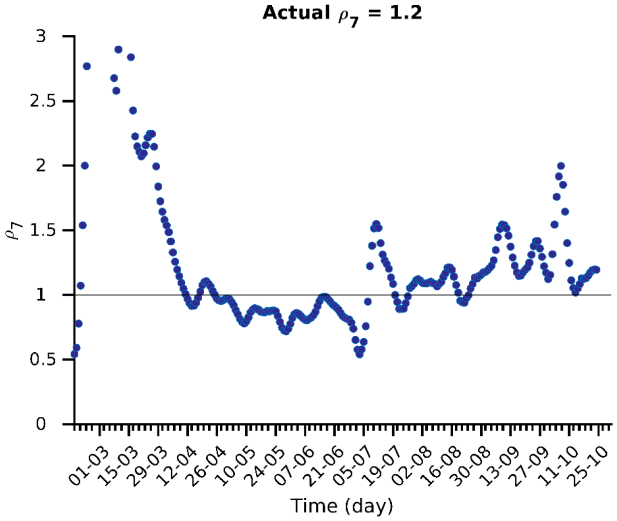
Day	Number of cases	95% Confidence Interval
26-10-2020	895091 (+21291)	[873800 - 916722]
28-10-2020	938382 (+21768)	[915752 - 961012]
30-10-2020	982639 (+22247)	[957743 - 1007535]

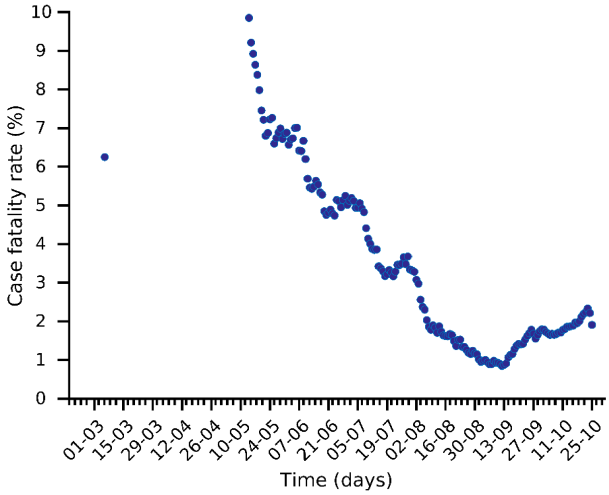
Current indicators

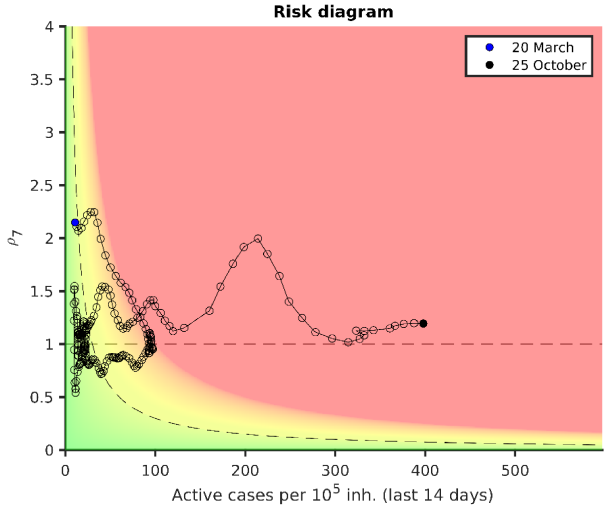
A_{14}	EPG	CFR
398	475	1.90 %

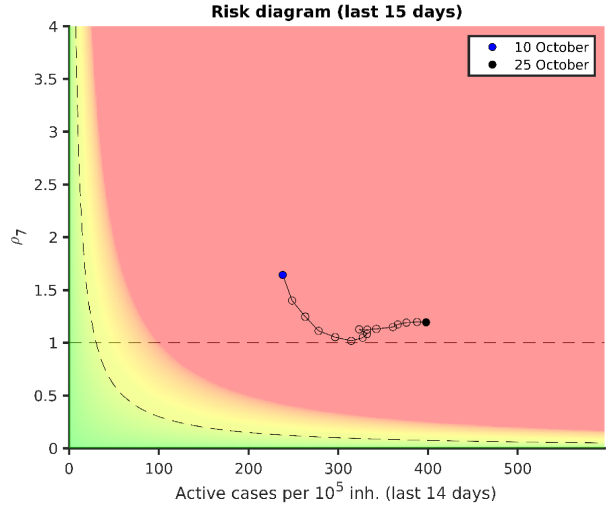




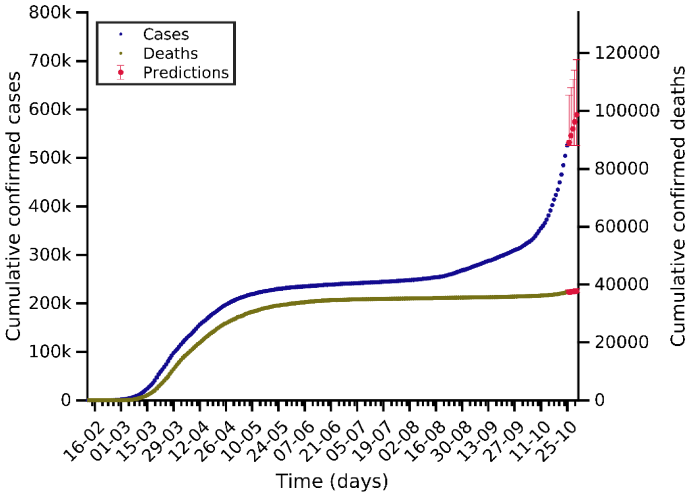








Italy 25-10-2020. Pop: 60.5M. Cumulative incidence: 870/10⁵

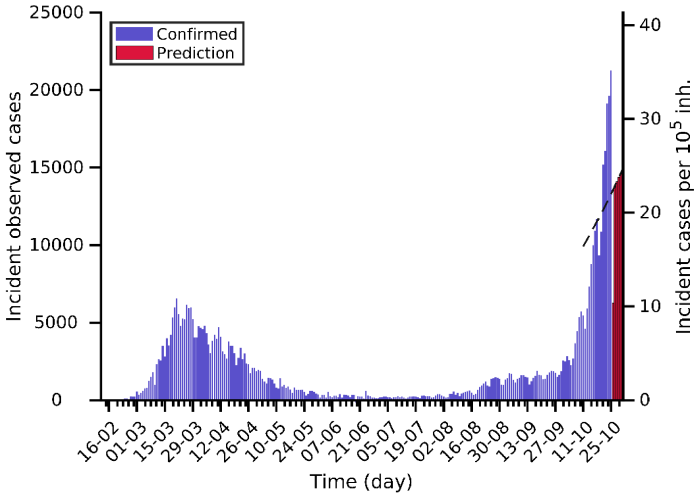


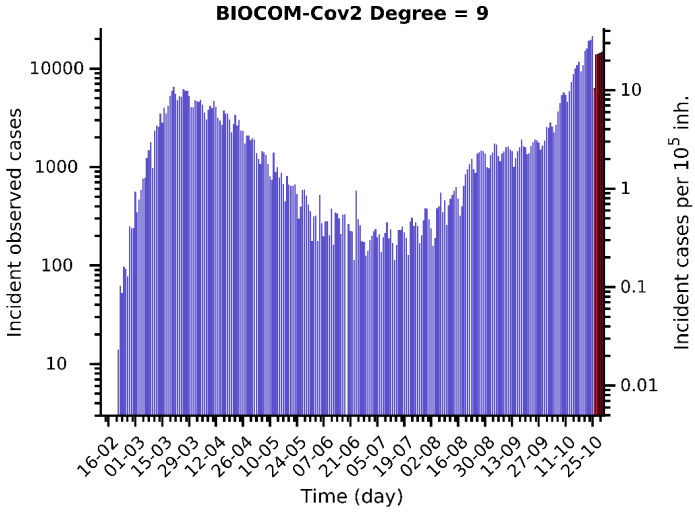
Predictions for next days

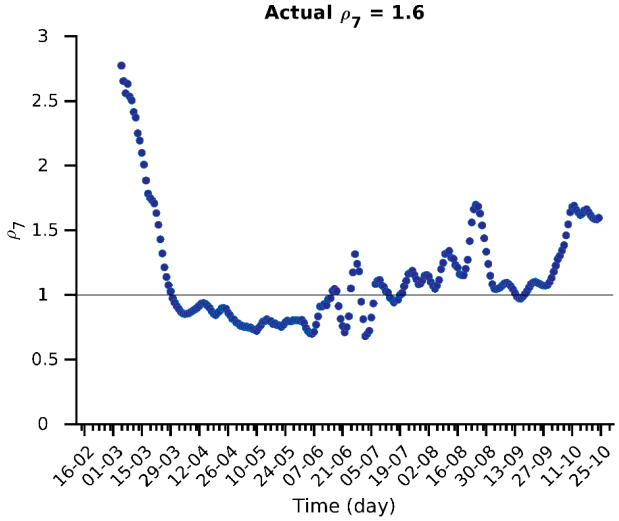
Day	Number of cases	95% Confidence Interval
26-10-2020	532038 (+6256)	[525782 - 629490]
28-10-2020	559972 (+14102)	[525782 - 662208]
30-10-2020	589001 (+14653)	[525782 - 702387]

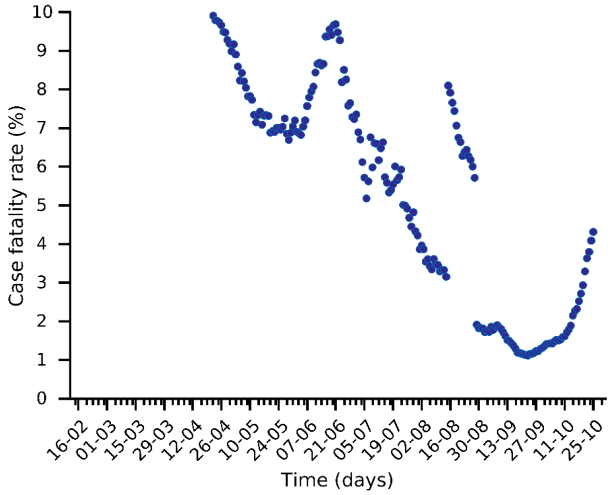
Current indicators

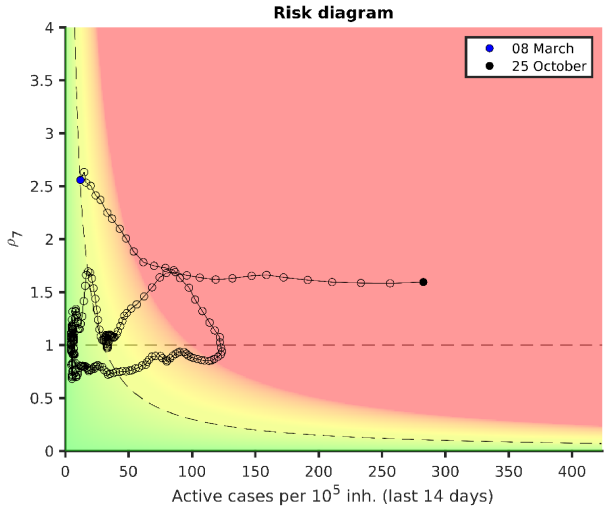
A_{14}	EPG	CFR
283	451	4.31 %

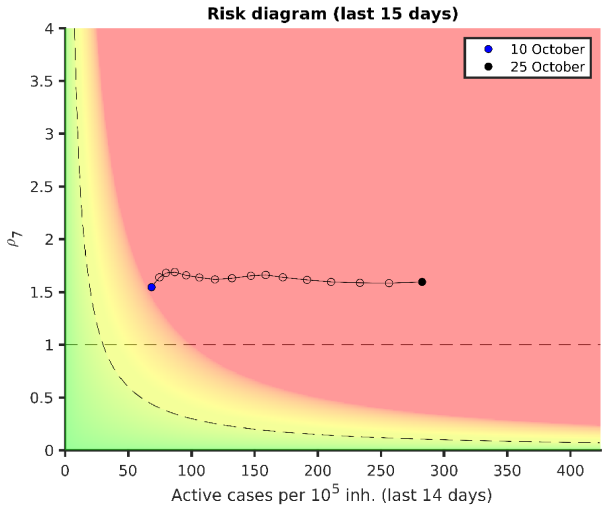




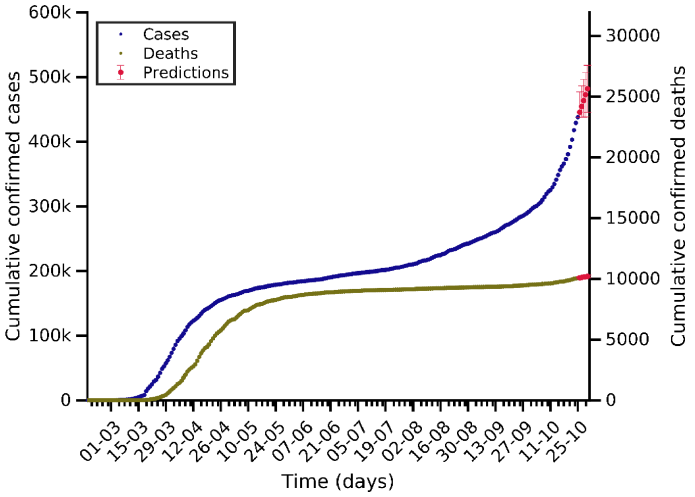








Germany 25-10-2020. Pop: 83.8M. Cumulative incidence: 523/10⁵

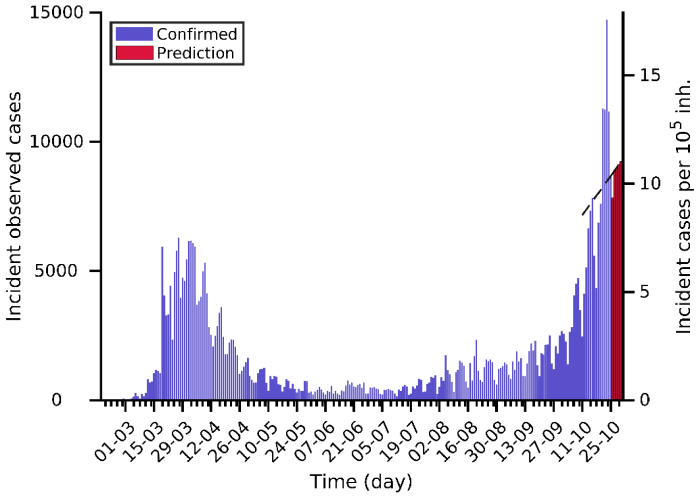


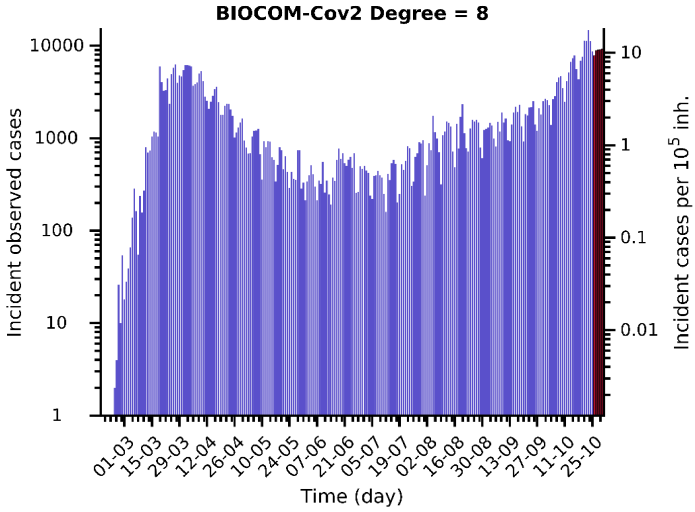
Predictions for next days

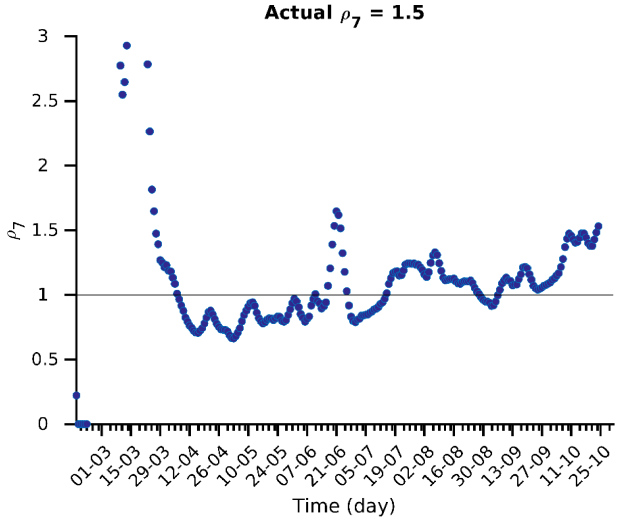
Day	Number of cases	95% Confidence Interval
26-10-2020	445694 (+7828)	[437866 - 477168]
28-10-2020	463603 (+9010)	[437866 - 496515]
30-10-2020	481954 (+9230)	[445786 - 518122]

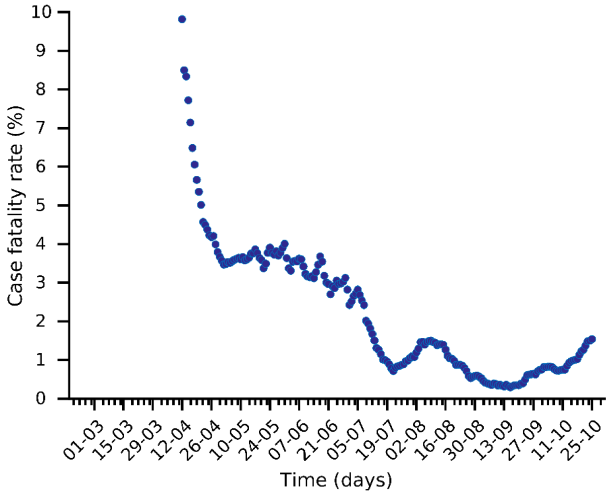
Current indicators

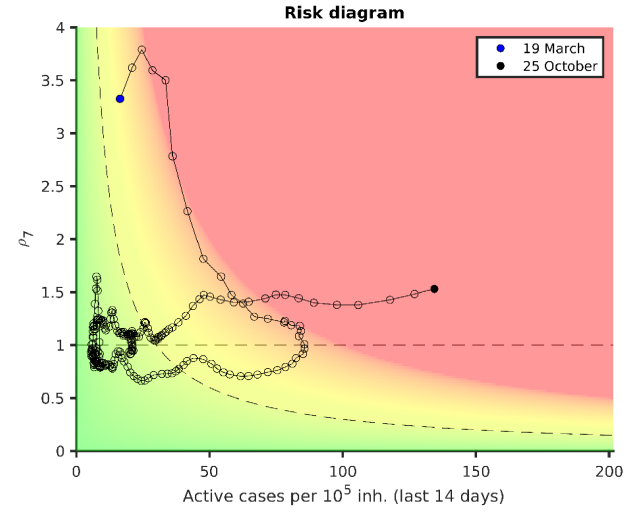
A_{14}	EPG	CFR
134	206	1.54 %

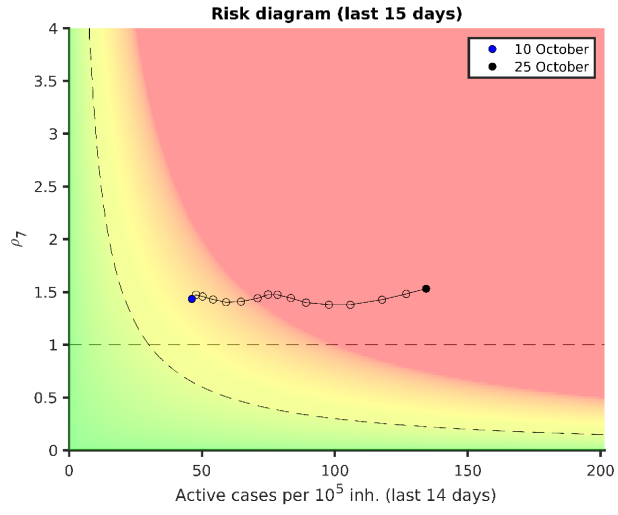




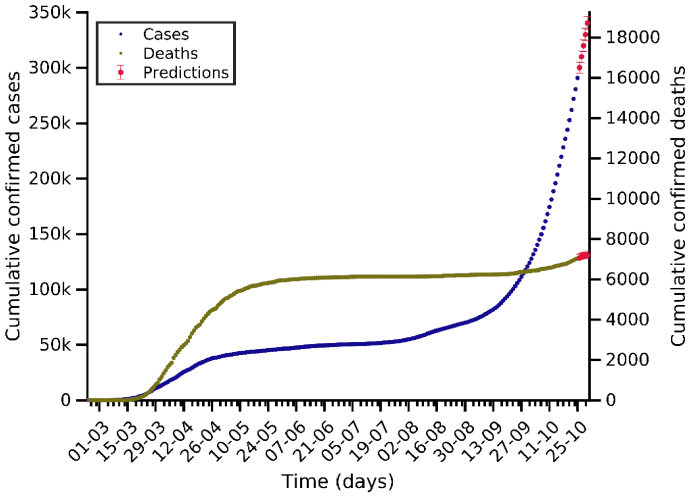








Netherlands 25-10-2020. Pop: 17.1M. Cumulative incidence: 1698/10^5

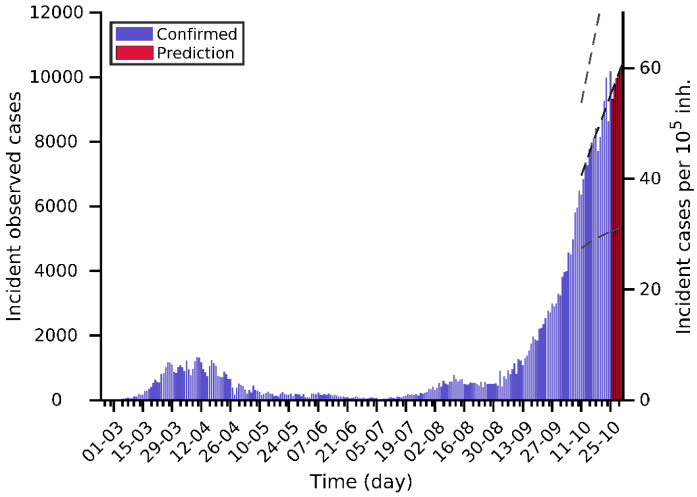


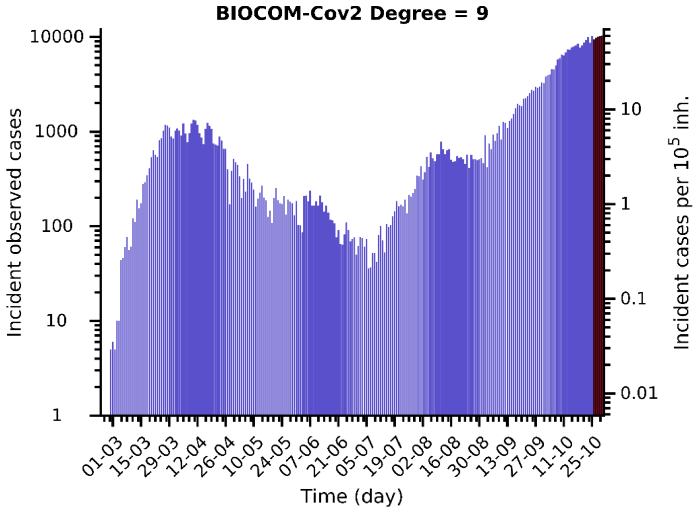
Predictions for next days

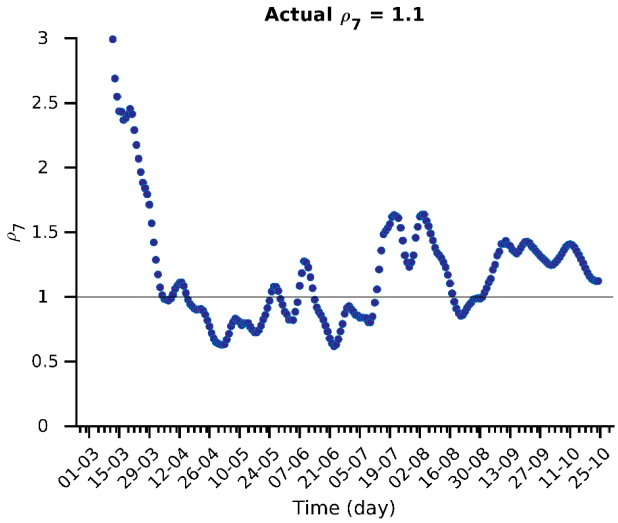
Day	Number of cases	95% Confidence Interval
26-10-2020	300244 (+9319)	[295167 - 305322]
28-10-2020	319991 (+9957)	[314660 - 325322]
30-10-2020	340402 (+10288)	[334483 - 346321]

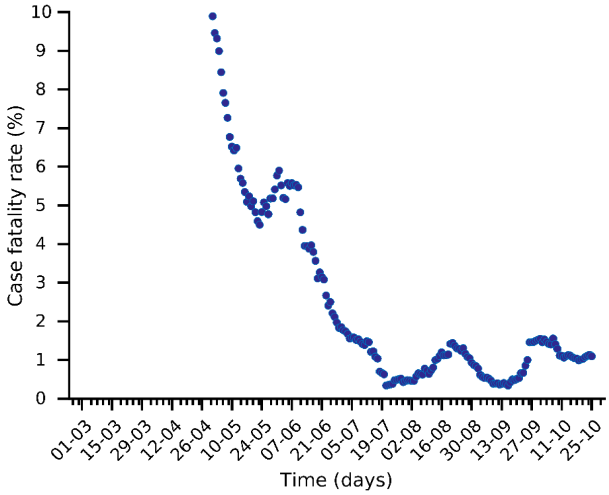
Current indicators

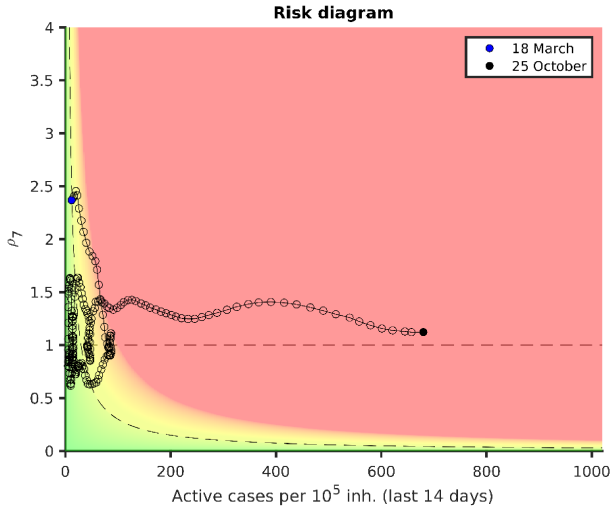
A_{14}	EPG	CFR
680	763	1.10 %

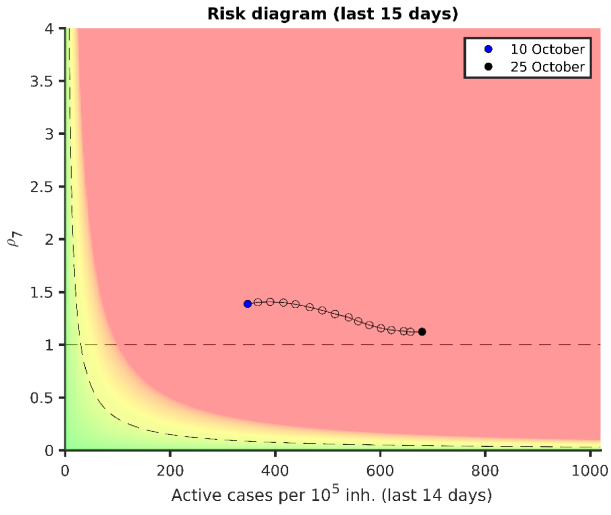




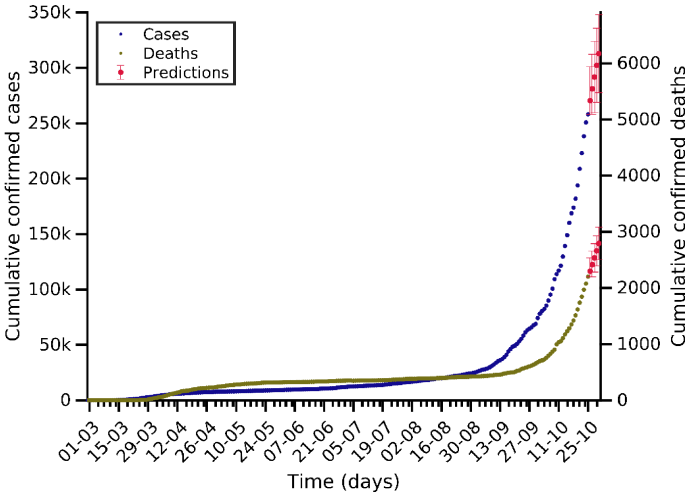








Czech Rep 25-10-2020. Pop: 10.7M. Cumulative incidence: 2410/10^5

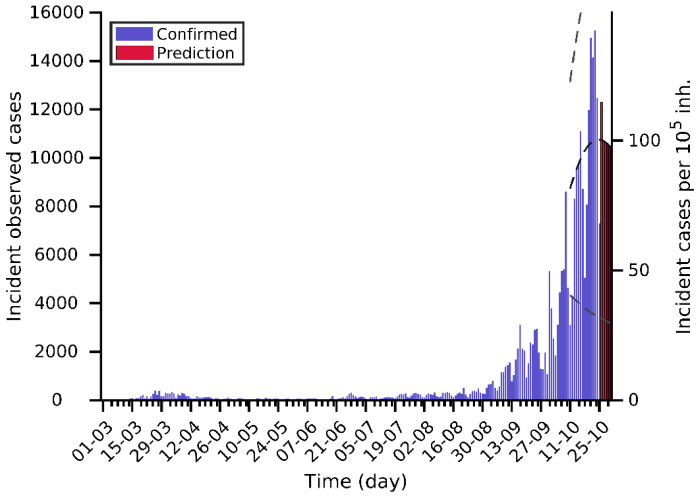


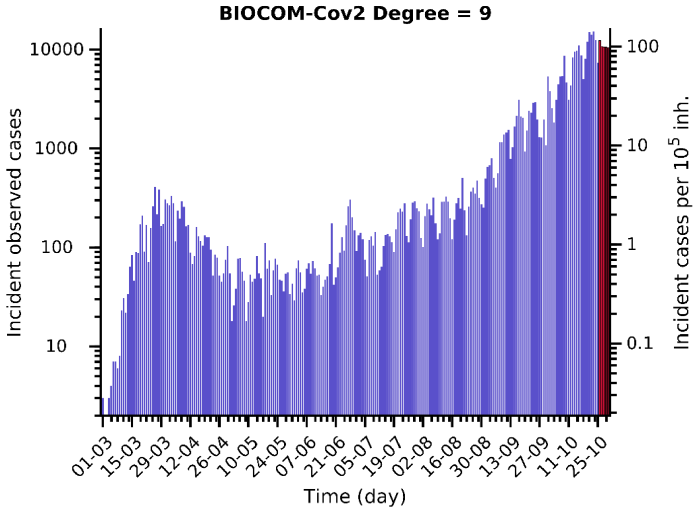
Predictions for next days

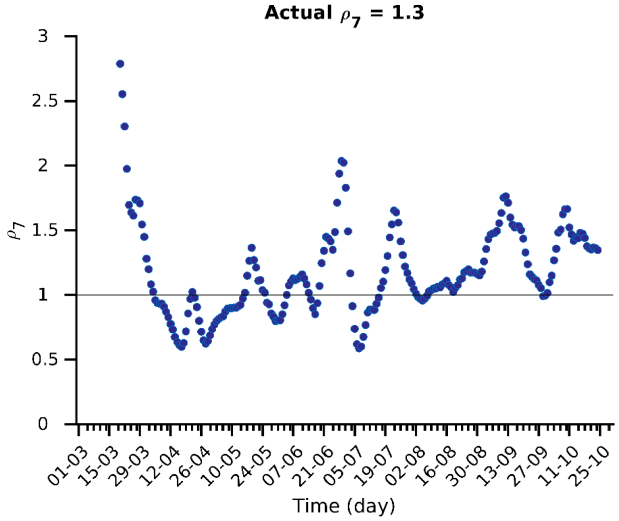
Day	Number of cases	95% Confidence Interval
26-10-2020	270388 (+12291)	[258097 - 301110]
28-10-2020	291731 (+10644)	[259623 - 323840]
30-10-2020	312786 (+10484)	[277649 - 347924]

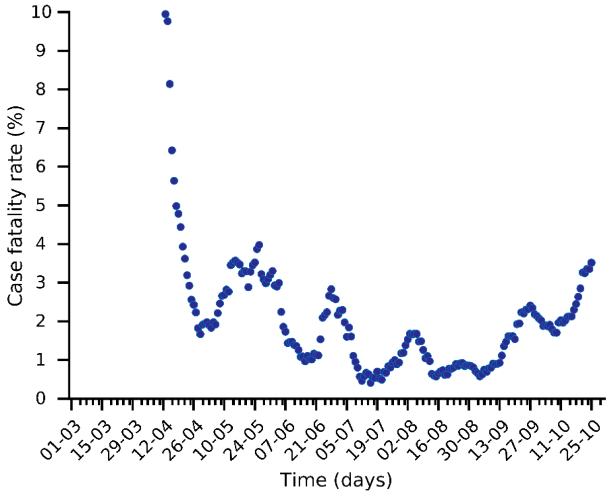
Current indicators

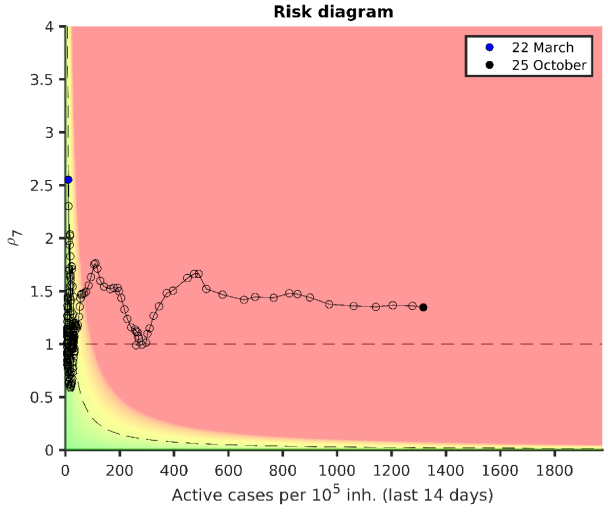
A_{14}	EPG	CFR
1317	1773	3.51 %

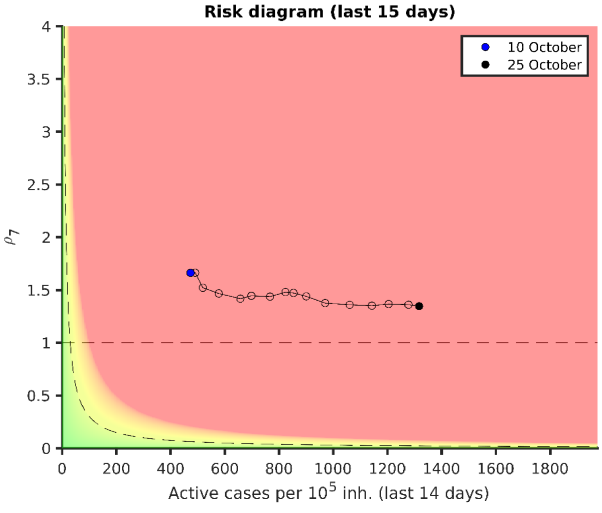




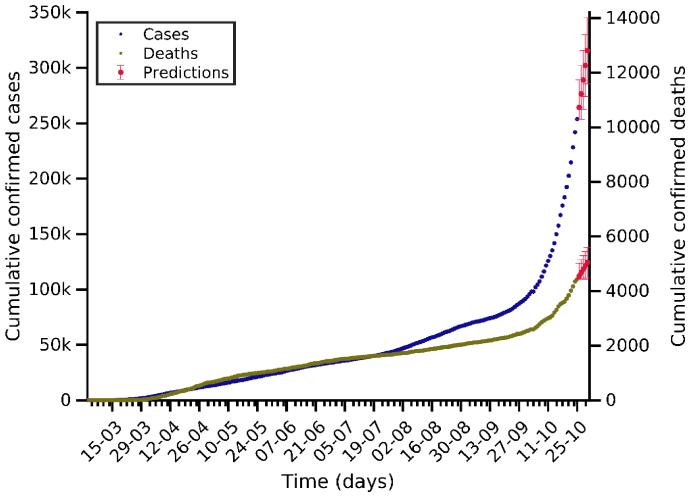








Poland 25-10-2020. Pop: 37.8M. Cumulative incidence: 670/10⁵

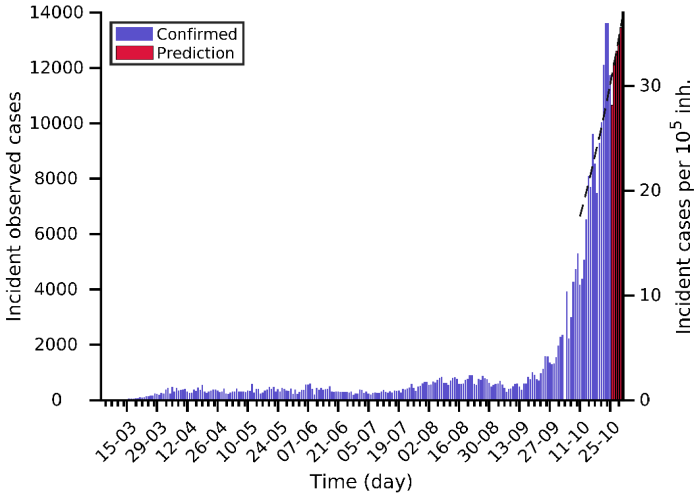


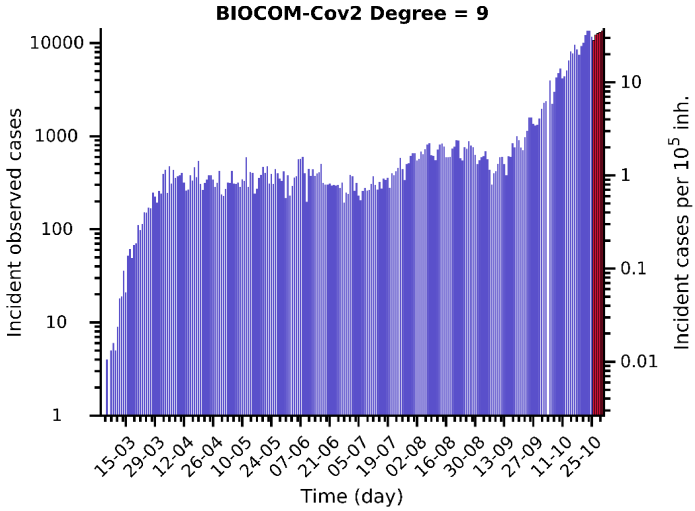
Predictions for next days

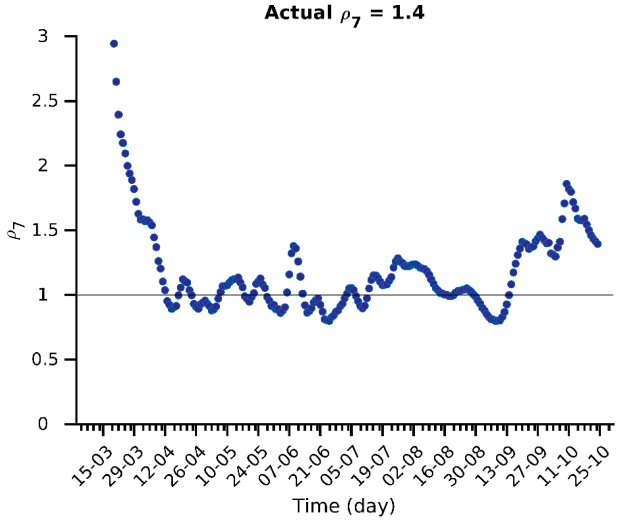
Day	Number of cases	95% Confidence Interval
26-10-2020	264344 (+10656)	[253688 - 289225]
28-10-2020	289151 (+12610)	[262820 - 315481]
30-10-2020	315642 (+13460)	[285717 - 345568]

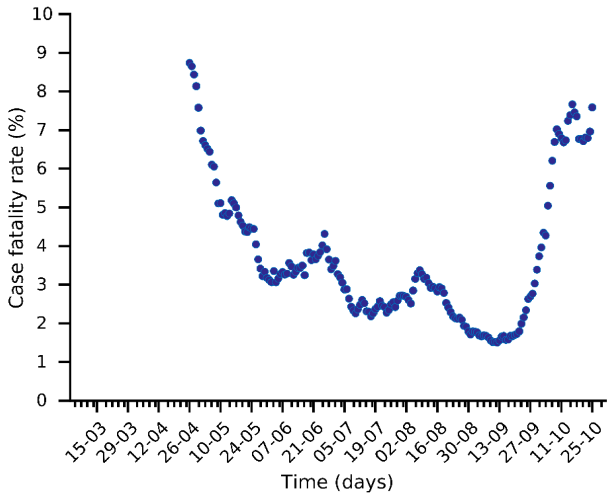
Current indicators

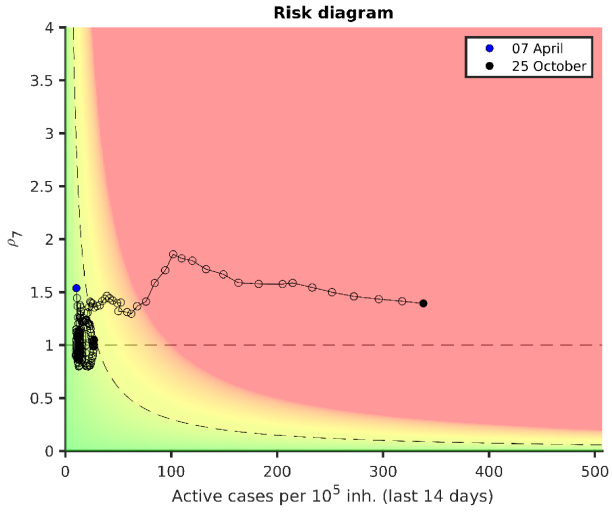
A_{14}	EPG	CFR
338	471	7.59 %

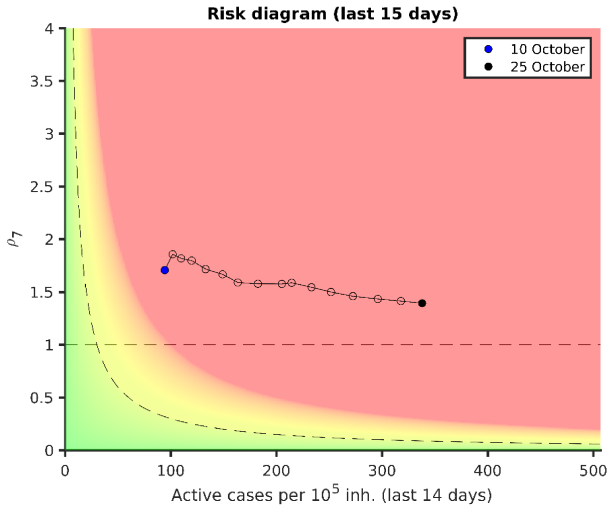




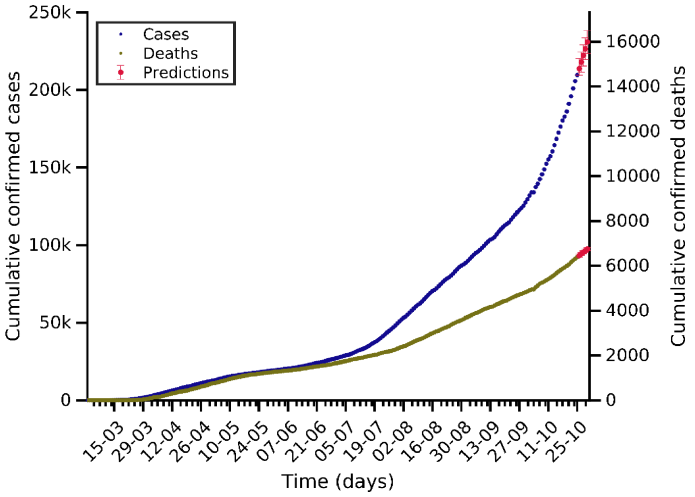








Romania 25-10-2020. Pop: 19.2M. Cumulative incidence: 1090/10⁵

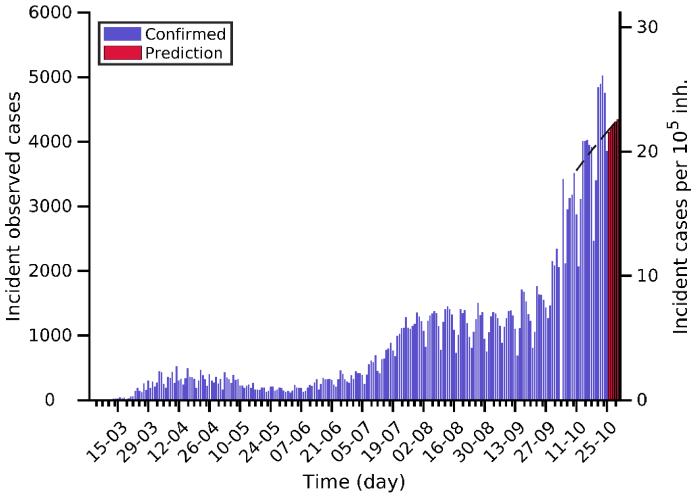


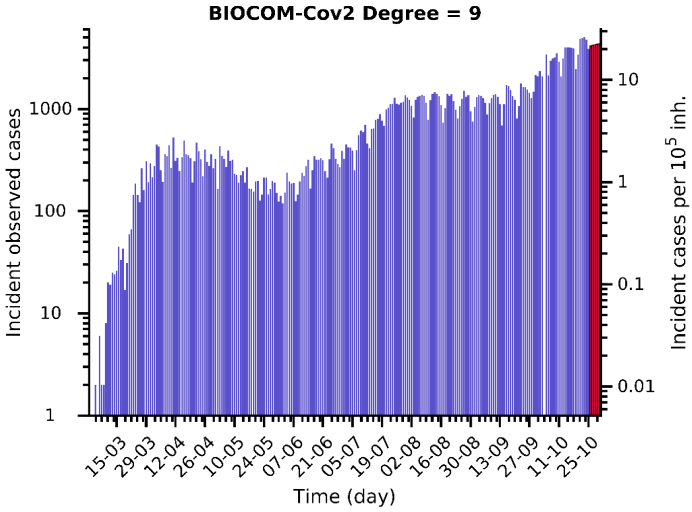
Predictions for next days

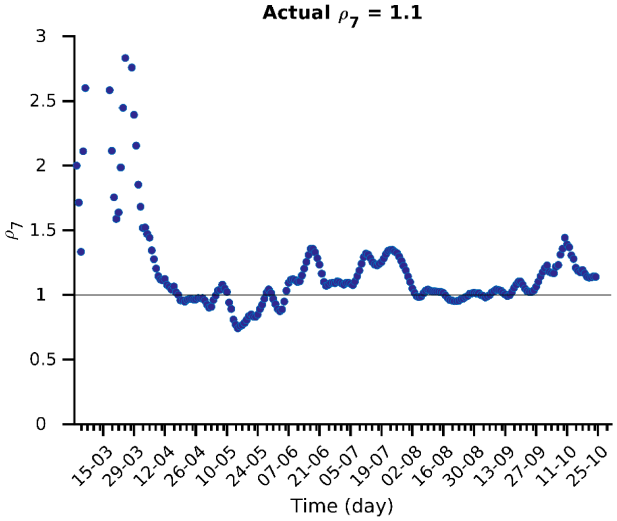
Day	Number of cases	95% Confidence Interval
26-10-2020	213798 (+4150)	[209648 - 220241]
28-10-2020	222294 (+4267)	[215564 - 229023]
30-10-2020	230940 (+4342)	[223565 - 238314]

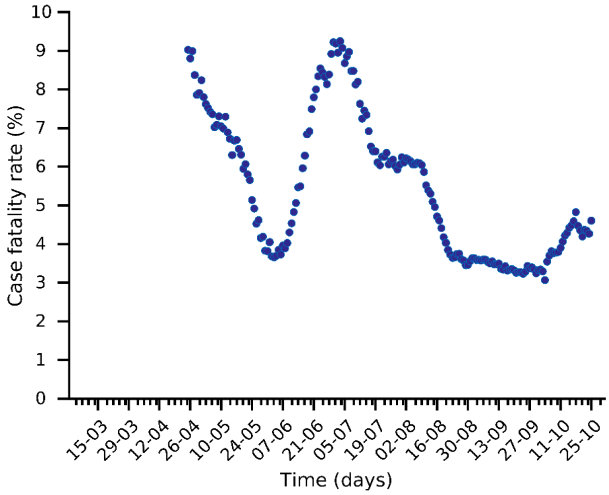
Current indicators

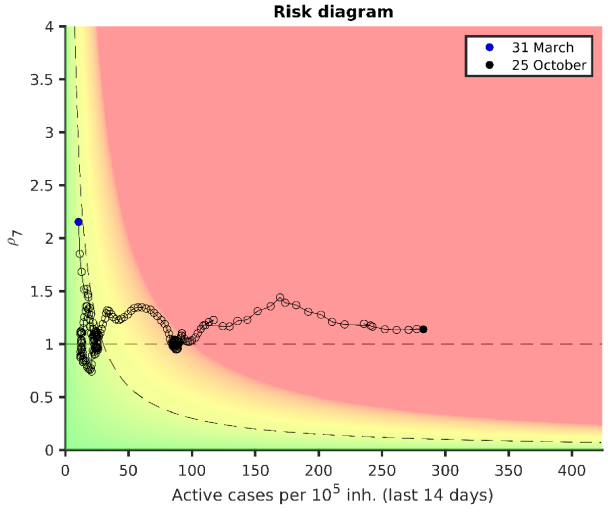
A_{14}	EPG	CFR
283	322	4.60 %

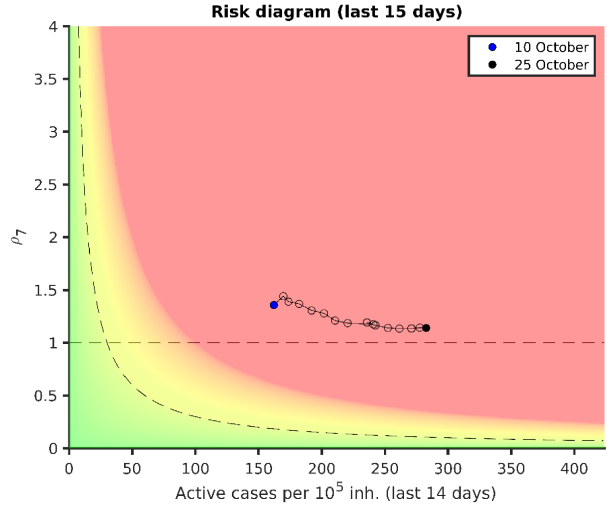




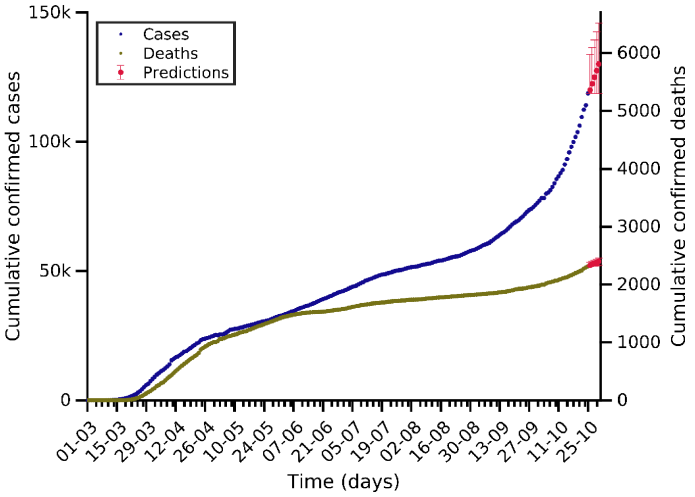








Portugal 25-10-2020. Pop: 10.2M. Cumulative incidence: 1164/10⁵

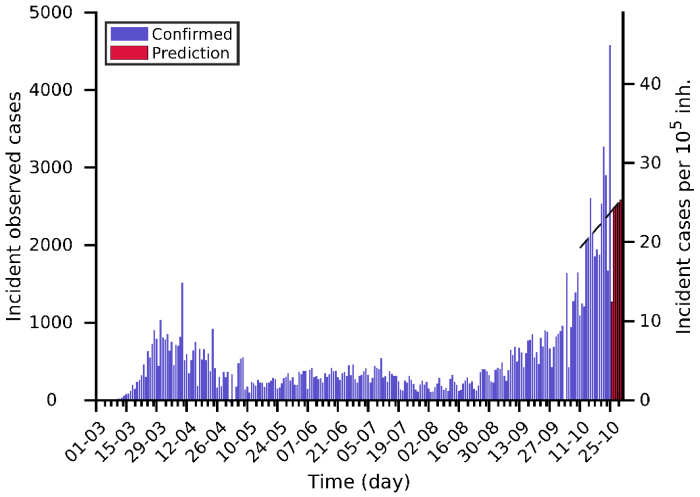


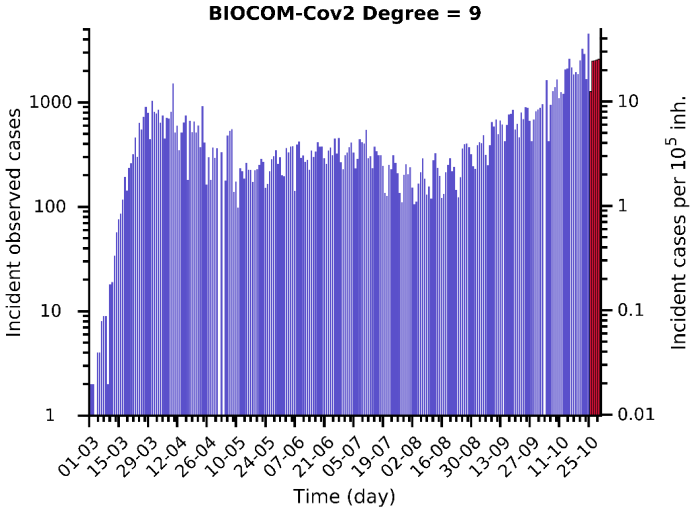
Predictions for next days

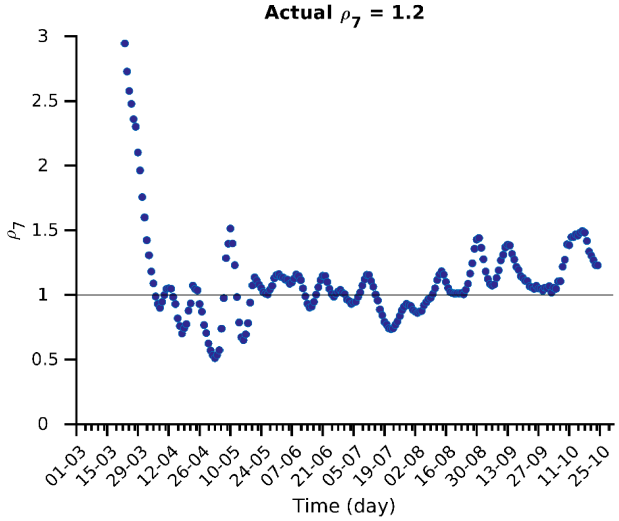
Day	Number of cases	95% Confidence Interval
26-10-2020	119953 (+1267)	[118686 - 133721]
28-10-2020	124952 (+2516)	[118686 - 139356]
30-10-2020	130086 (+2584)	[118686 - 145937]

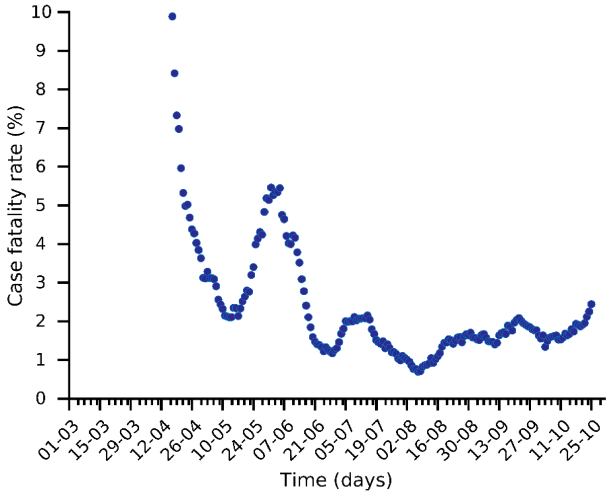
Current indicators

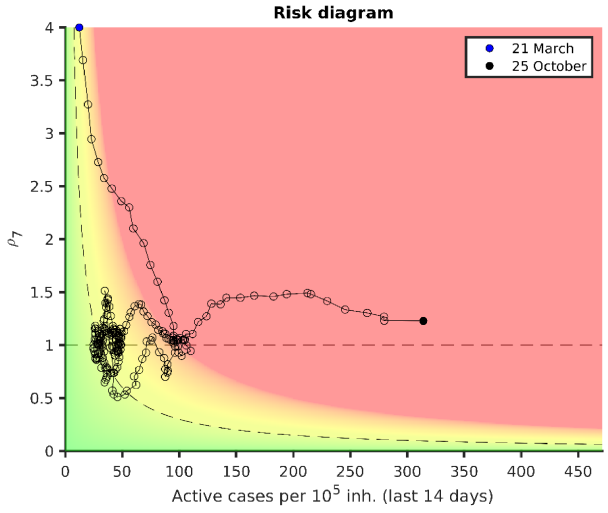
A_{14}	EPG	CFR
314	386	2.44 %

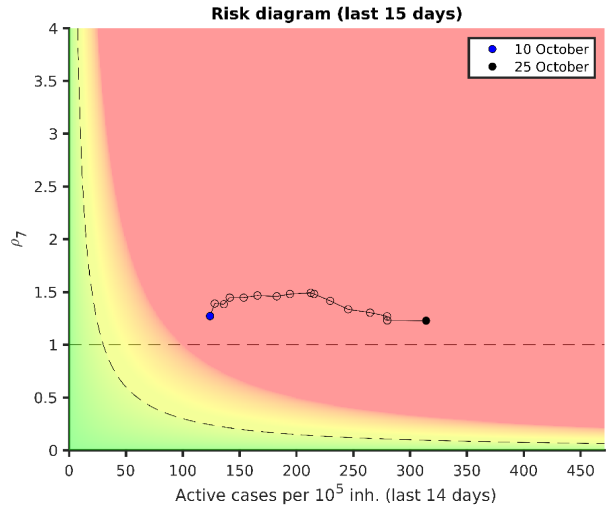




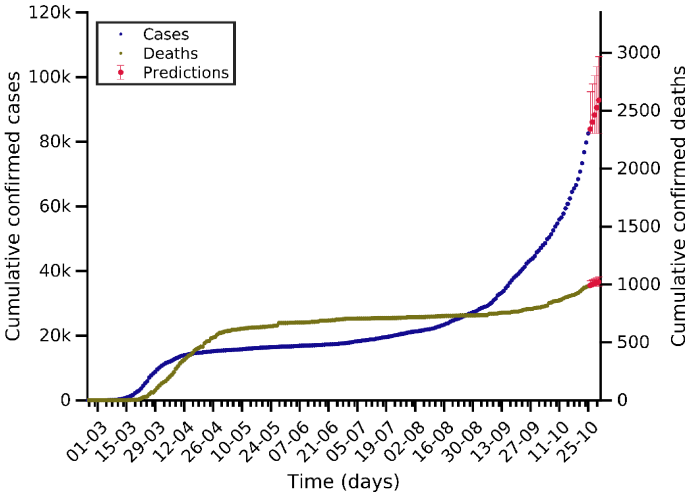








Austria 25-10-2020. Pop: 9.0M. Cumulative incidence: 916/10⁵

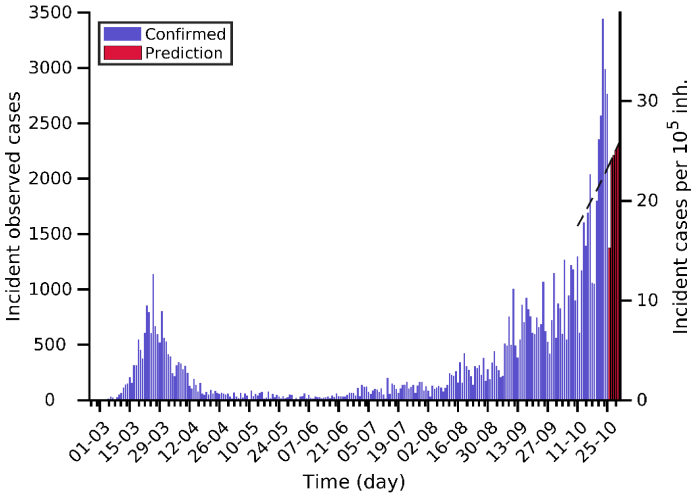


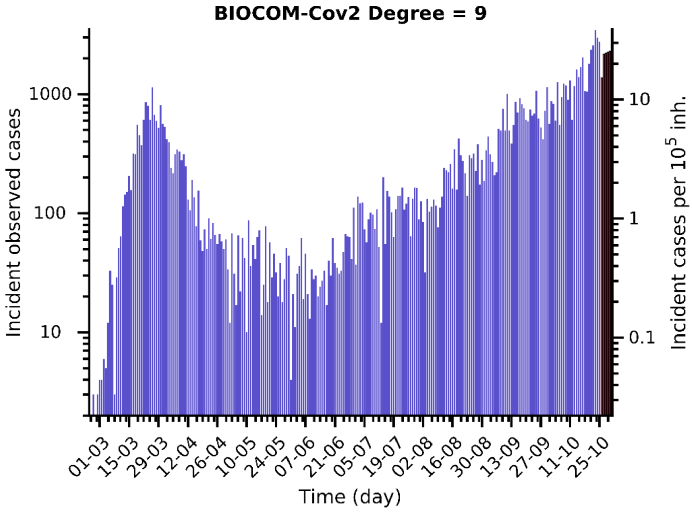
Predictions for next days

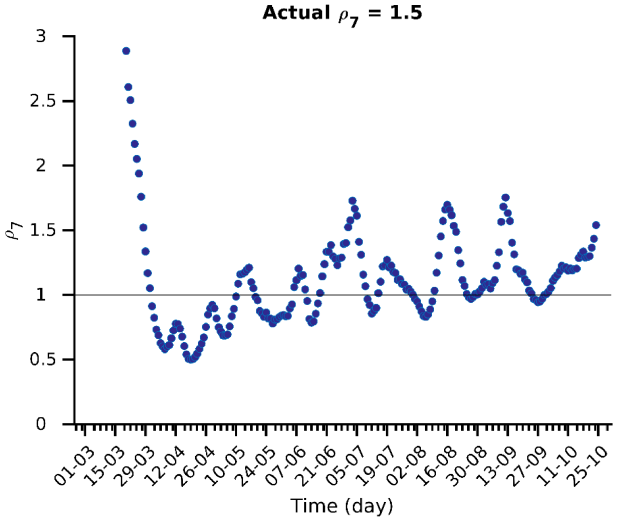
Day	Number of cases	95% Confidence Interval
26-10-2020	83910 (+1374)	[82536 - 95488]
28-10-2020	88293 (+2212)	[82536 - 100437]
30-10-2020	92843 (+2295)	[82536 - 106302]

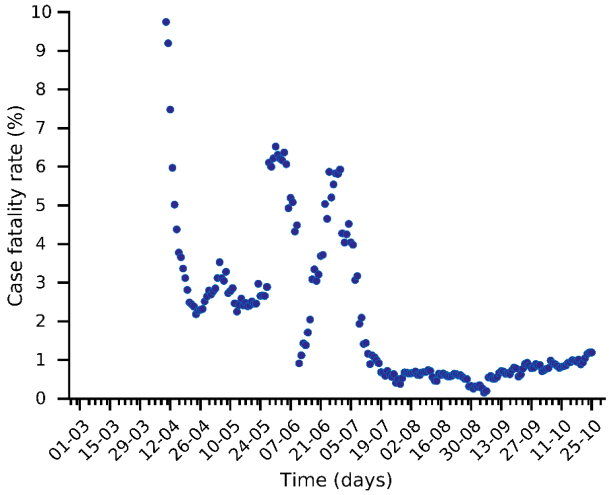
Current indicators

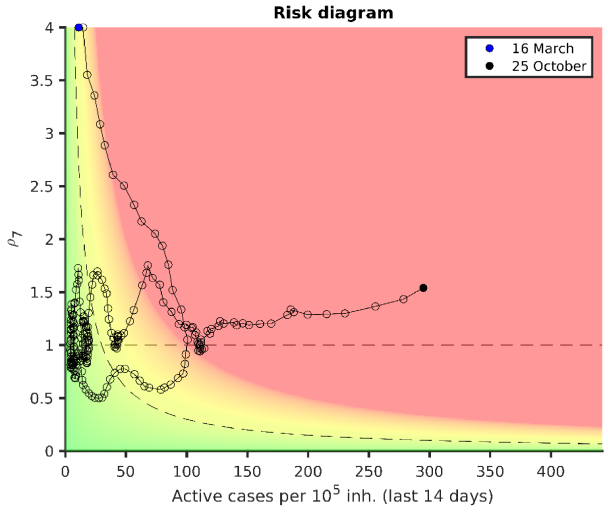
A_{14}	EPG	CFR
295	454	1.19 %

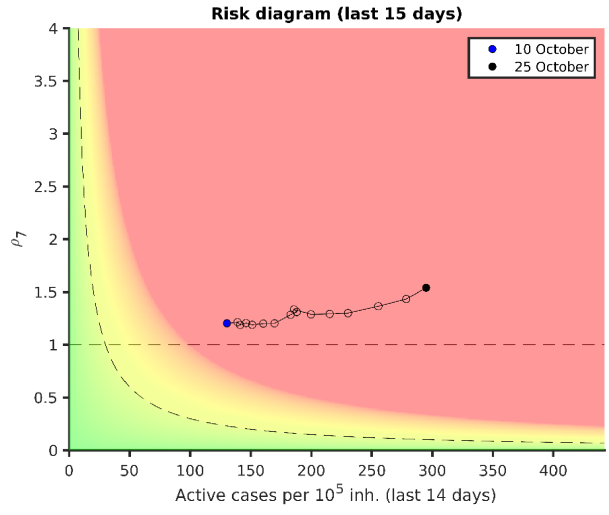




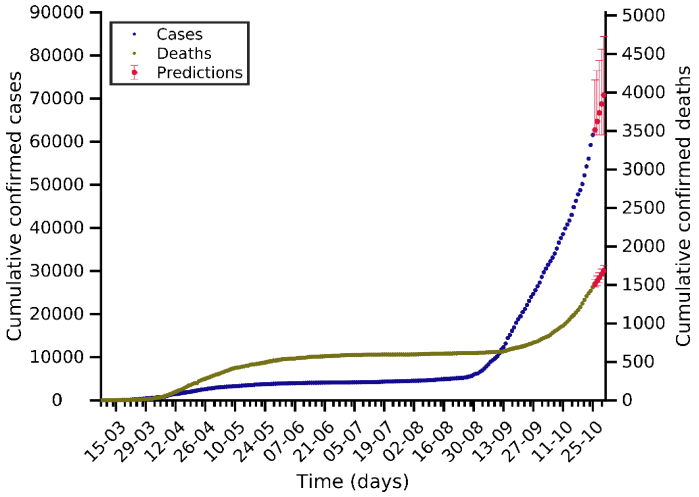








Hungary 25-10-2020. Pop: 9.7M. Cumulative incidence: 637/10^5

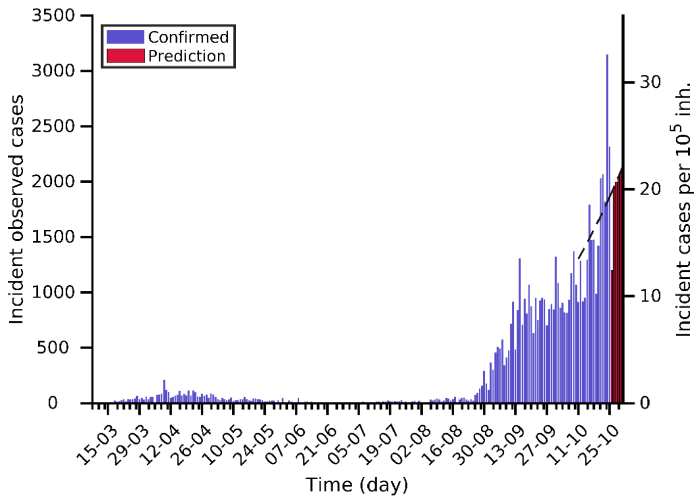


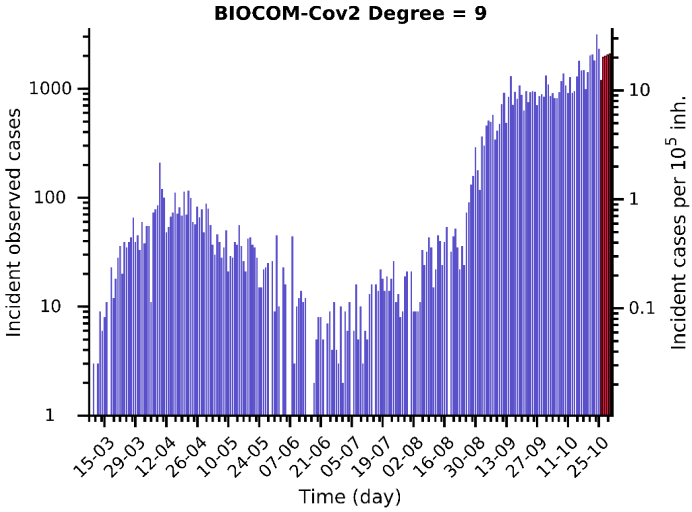
Predictions for next days

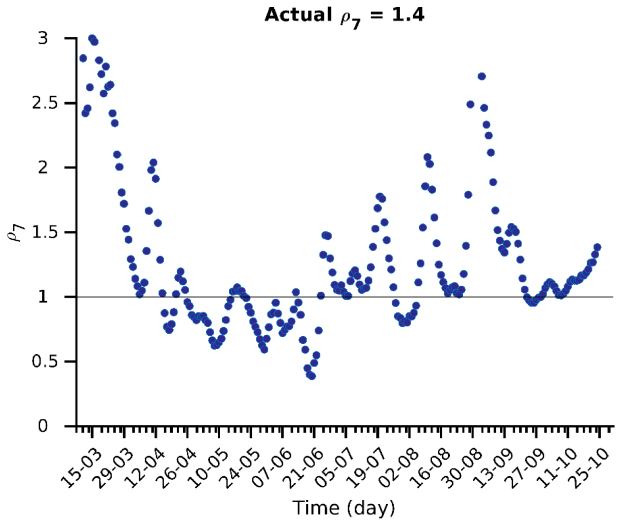
Day	Number of cases	95% Confidence Interval
26-10-2020	62762 (+1199)	[61563 - 74332]
28-10-2020	66710 (+1997)	[61563 - 78876]
30-10-2020	70845 (+2091)	[61563 - 84423]

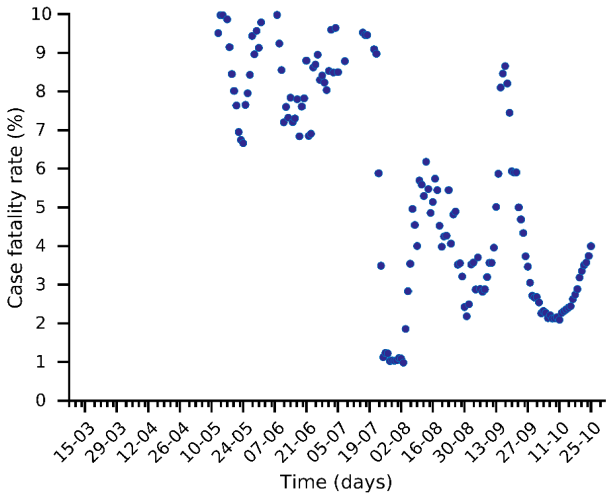
Current indicators

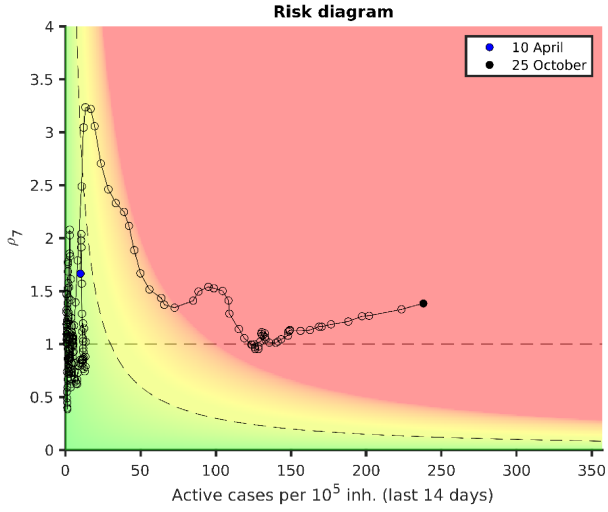
A_{14}	EPG	CFR
238	329	4.00 %

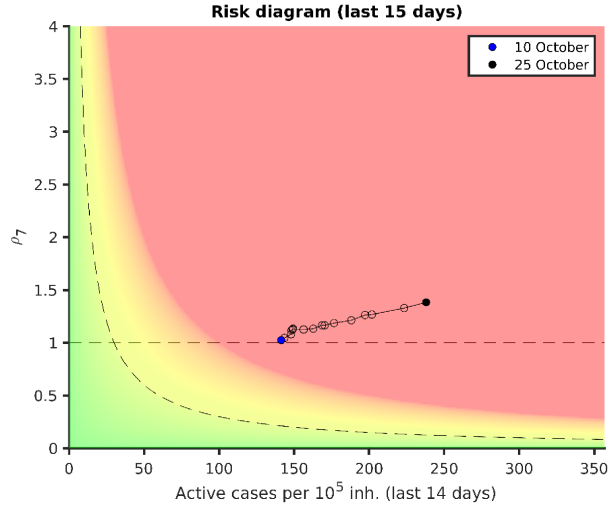




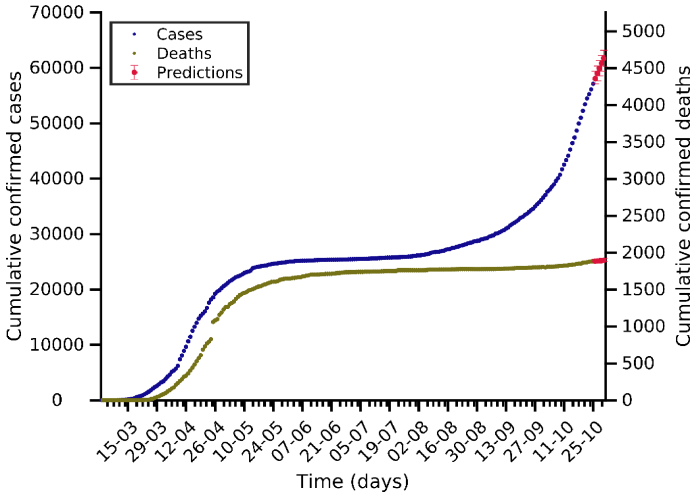








Ireland 25-10-2020. Pop: 4.9M. Cumulative incidence: 1157/10⁵

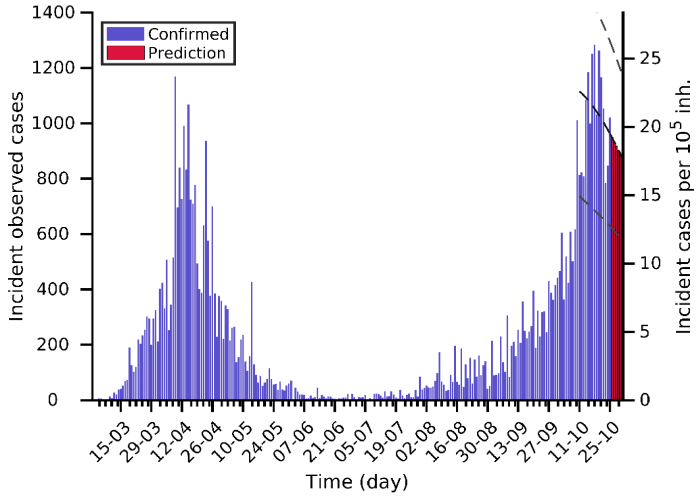


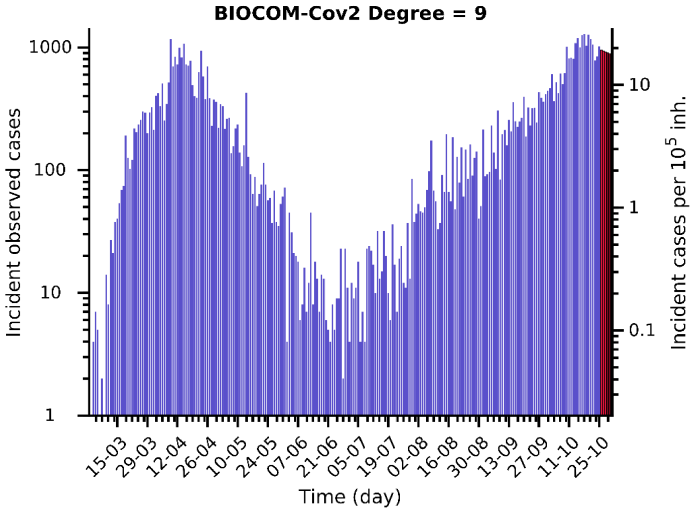
Predictions for next days

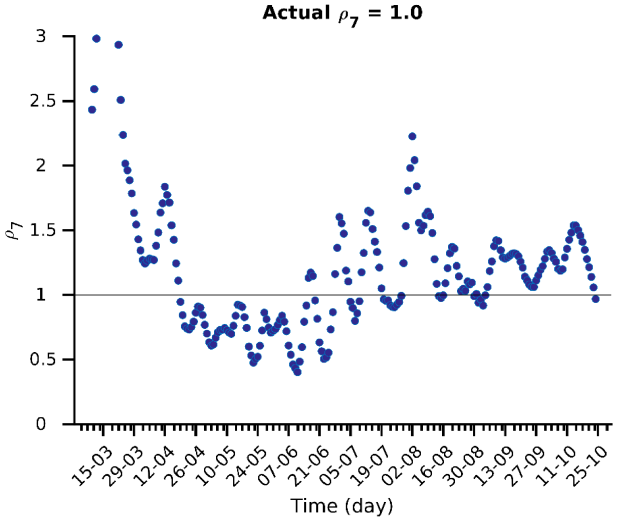
Day	Number of cases	95% Confidence Interval
26-10-2020	58077 (+949)	[57128 - 59408]
28-10-2020	59929 (+918)	[58549 - 61309]
30-10-2020	61719 (+887)	[60238 - 63200]

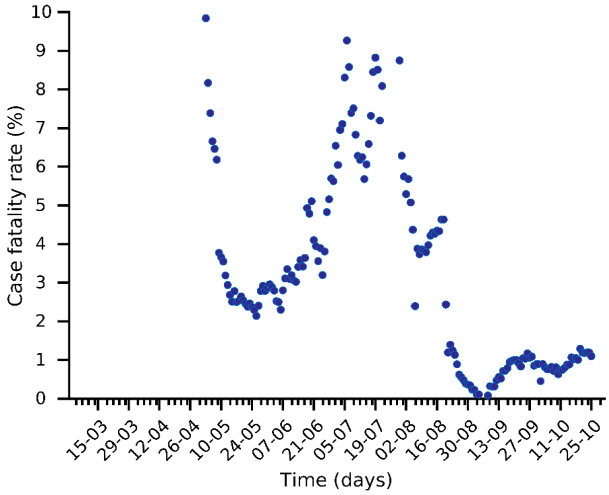
Current indicators

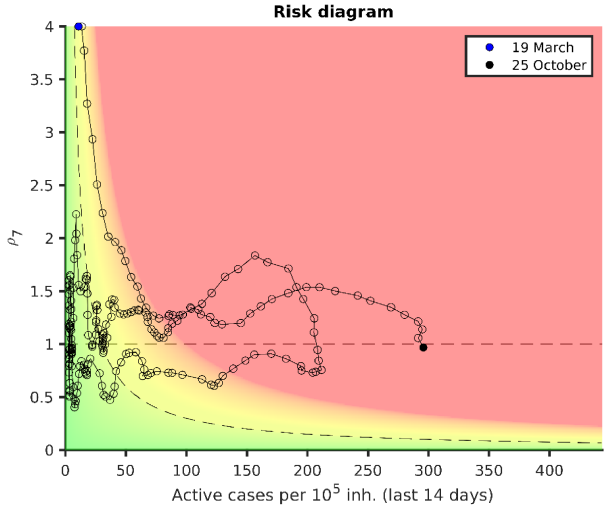
A_{14}	EPG	CFR
296	286	1.10 %

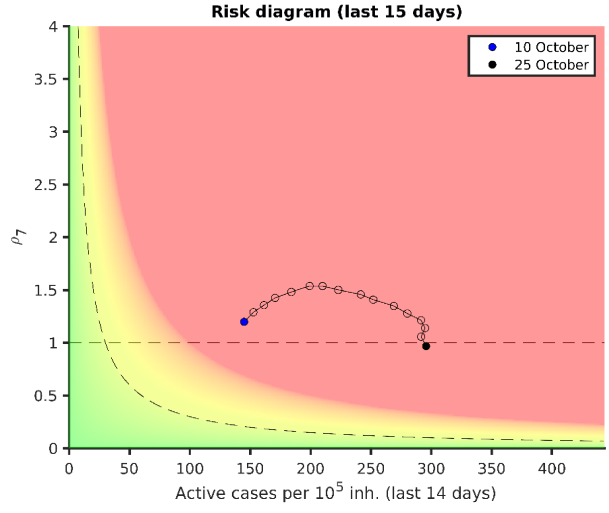




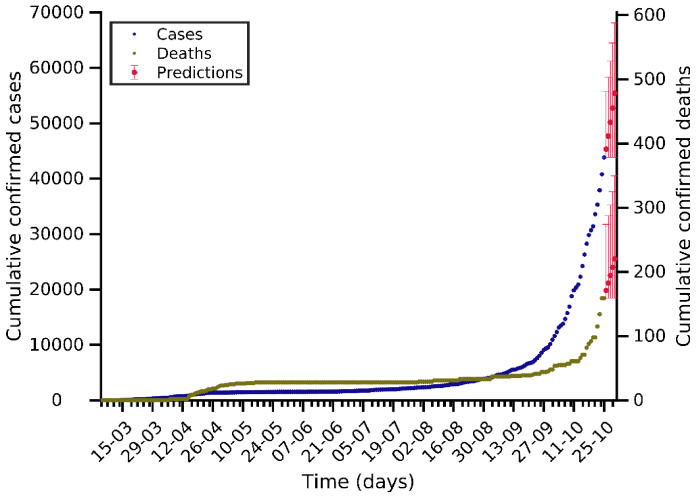








Slovakia 25-10-2020. Pop: 5.5M. Cumulative incidence: 803/10^5

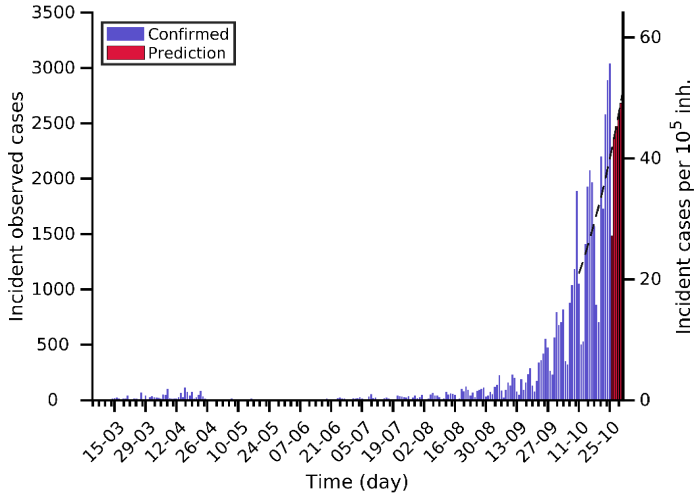


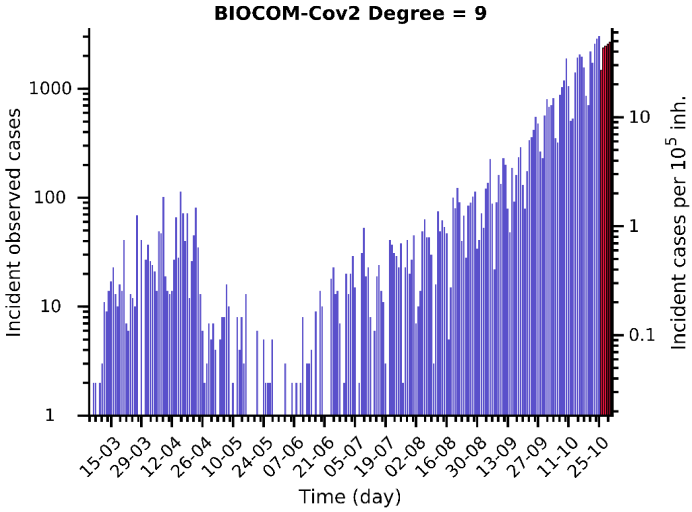
Predictions for next days

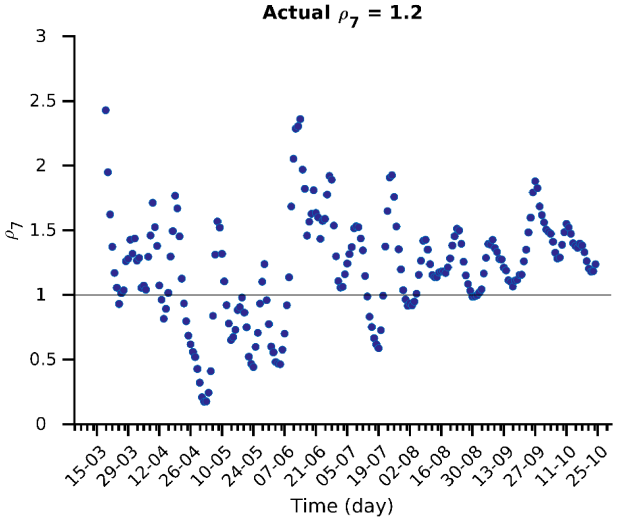
Day	Number of cases	95% Confidence Interval
26-10-2020	45326 (+1483)	[43843 - 55729]
28-10-2020	50170 (+2472)	[43843 - 61225]
30-10-2020	55427 (+2682)	[43843 - 68145]

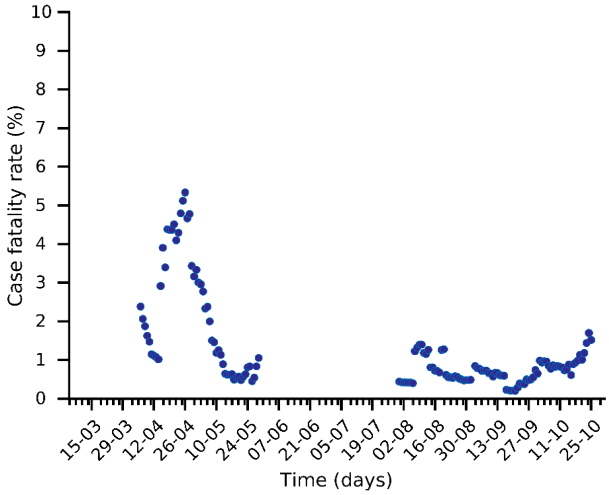
Current indicators

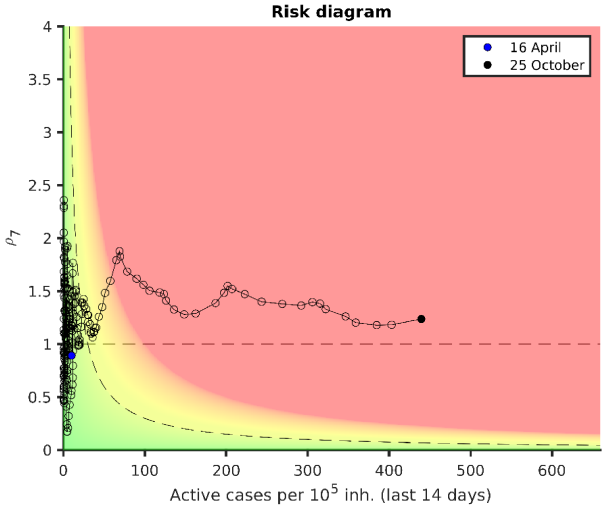
A_{14}	EPG	CFR
439	544	1.52 %

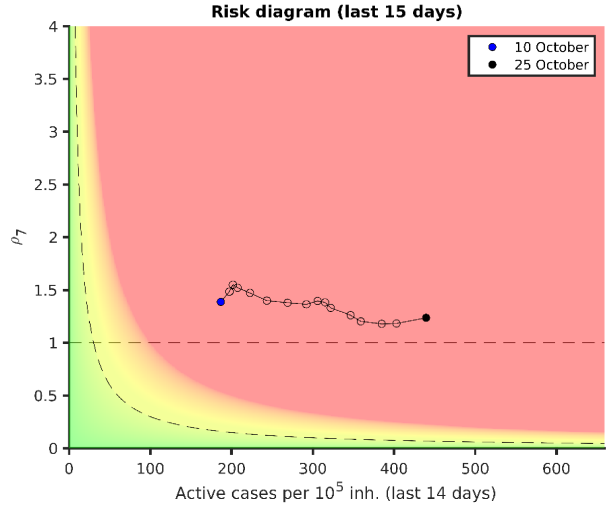




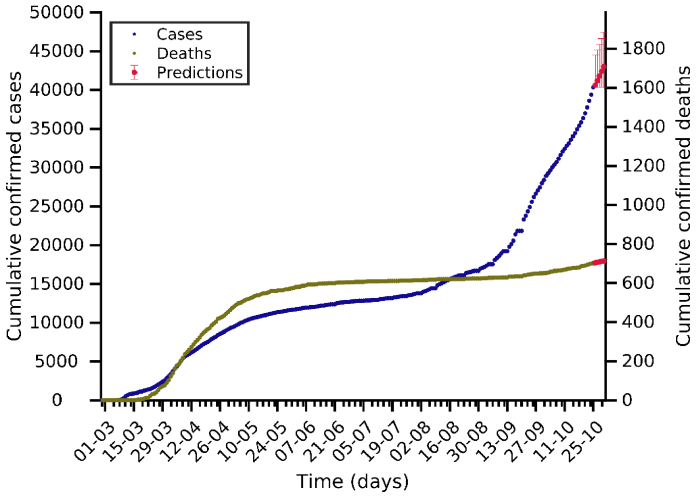








Denmark 25-10-2020. Pop: 5.8M. Cumulative incidence: 697/10⁵

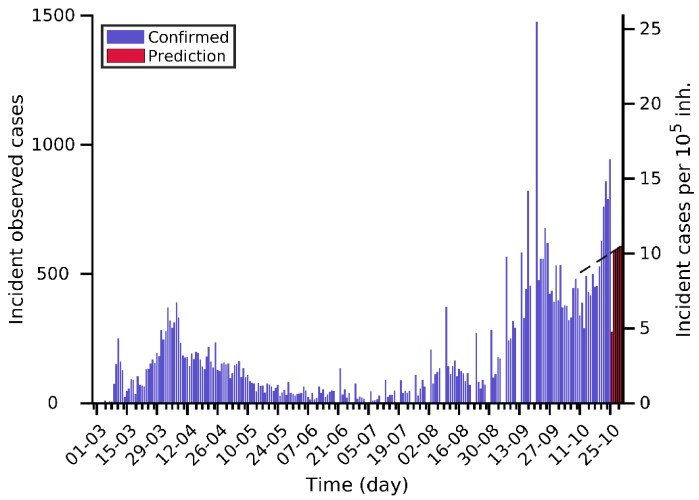


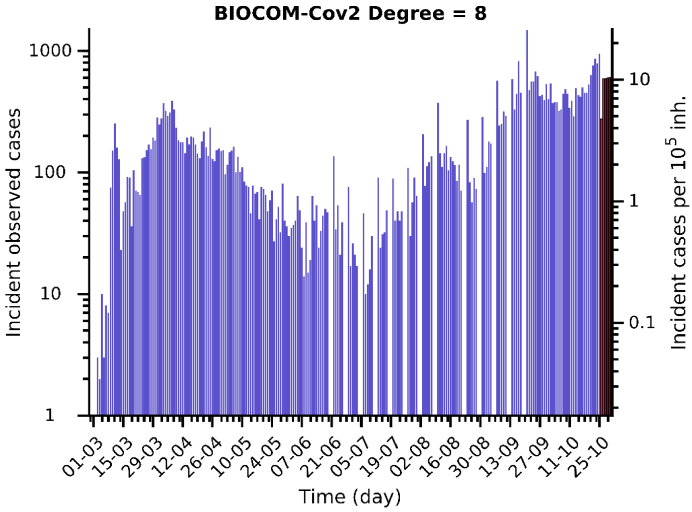
Predictions for next days

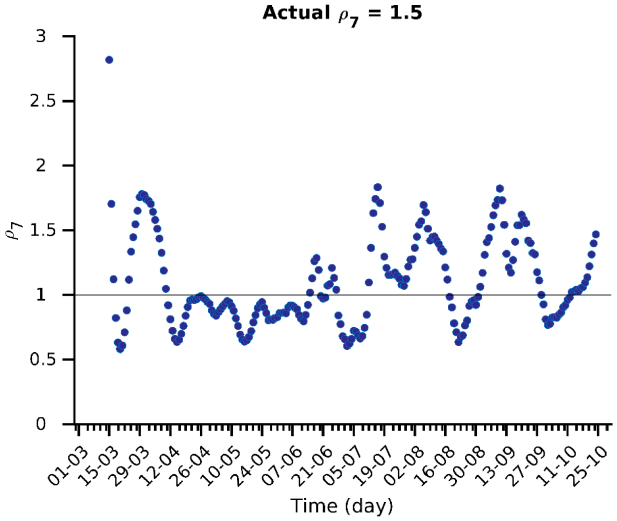
Day	Number of cases	95% Confidence Interval
26-10-2020	40631 (+275)	[40356 - 44524]
28-10-2020	41817 (+596)	[40356 - 45880]
30-10-2020	43025 (+606)	[40356 - 47466]

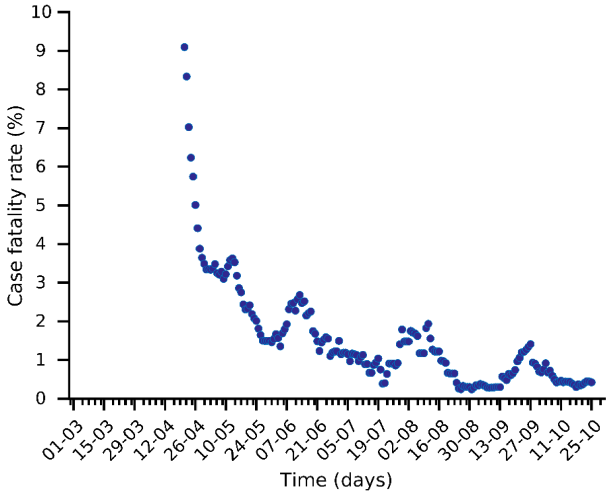
Current indicators

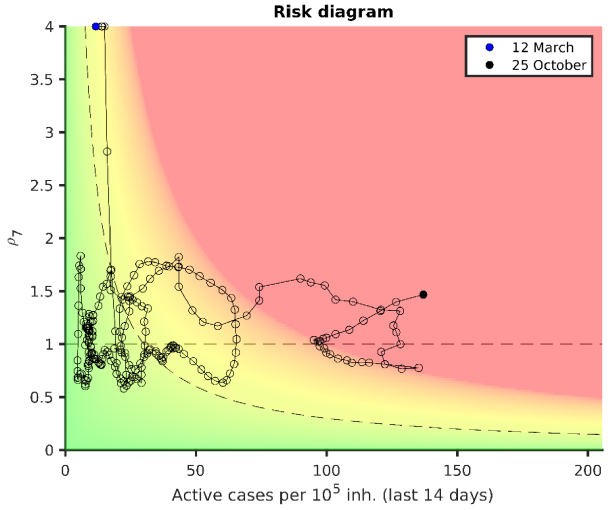
A_{14}	EPG	CFR
137	201	0.42 %

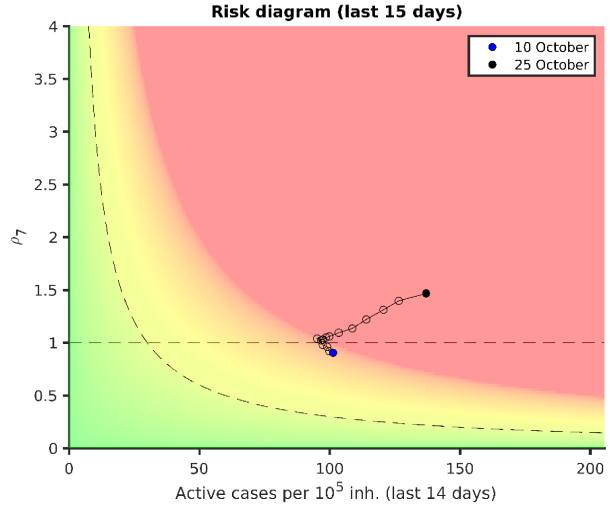




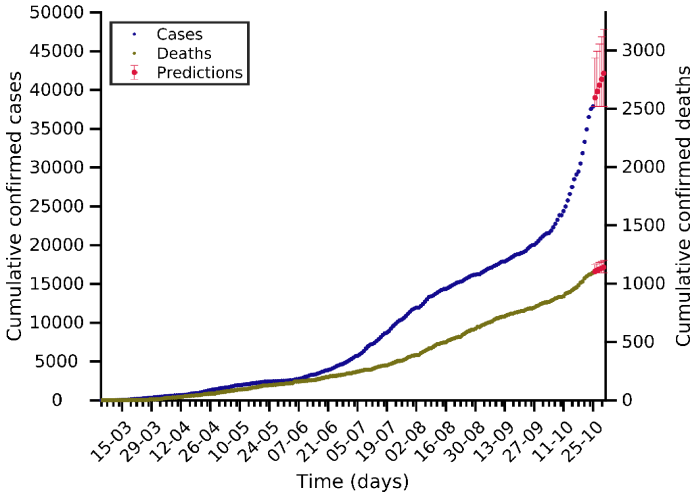








Bulgaria 25-10-2020. Pop: 6.9M. Cumulative incidence: 545/10⁵

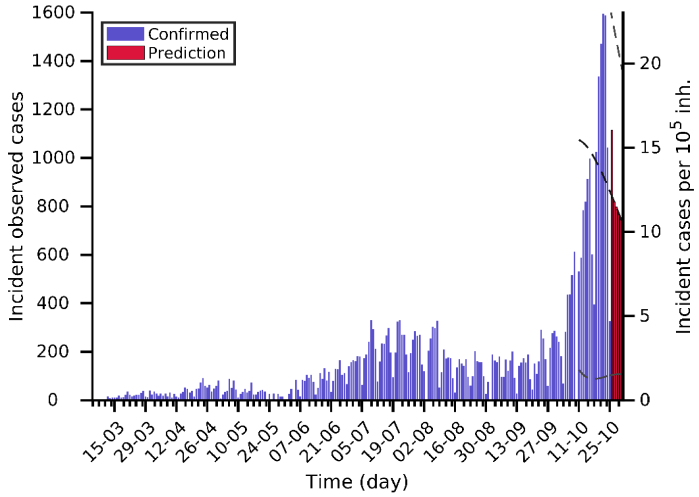


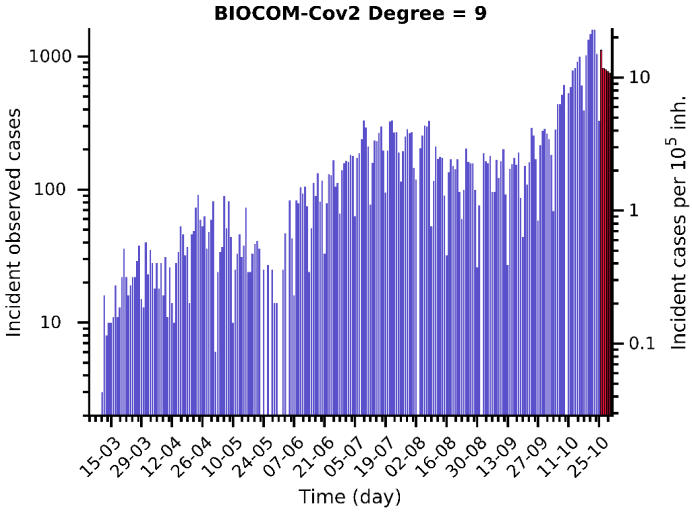
Predictions for next days

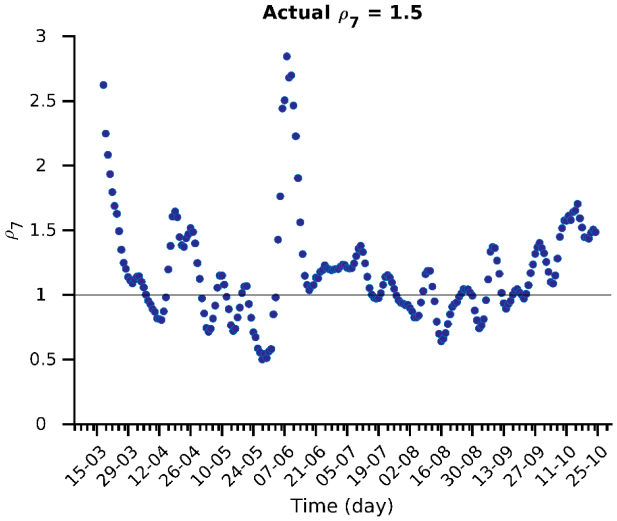
Day	Number of cases	95% Confidence Interval
26-10-2020	39003 (+1114)	[37889 - 44123]
28-10-2020	40620 (+797)	[37889 - 45918]
30-10-2020	42145 (+751)	[37889 - 47802]

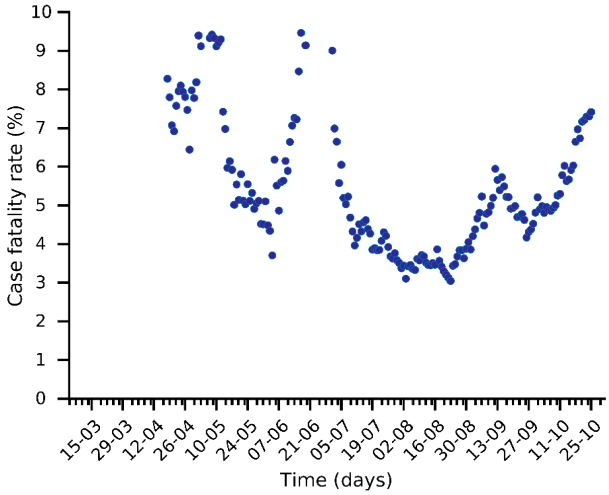
Current indicators

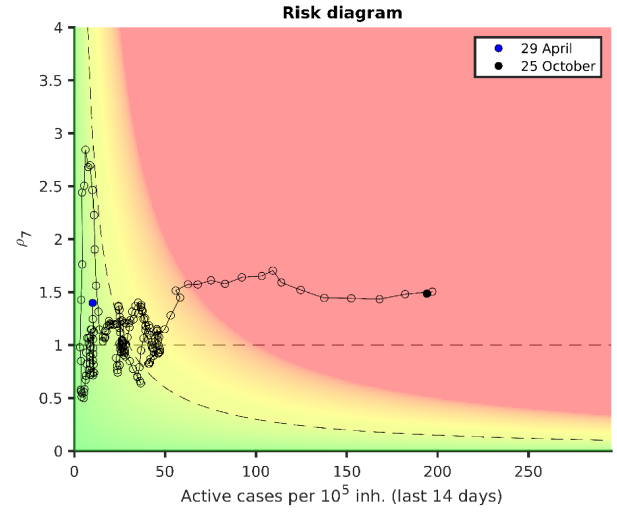
A_{14}	EPG	CFR
194	288	7.42 %

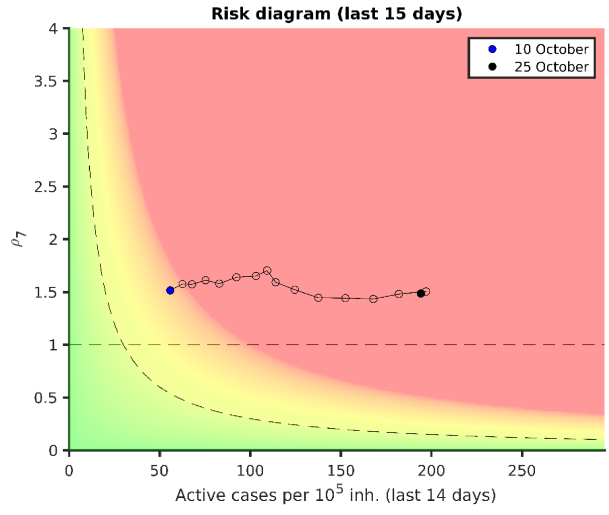




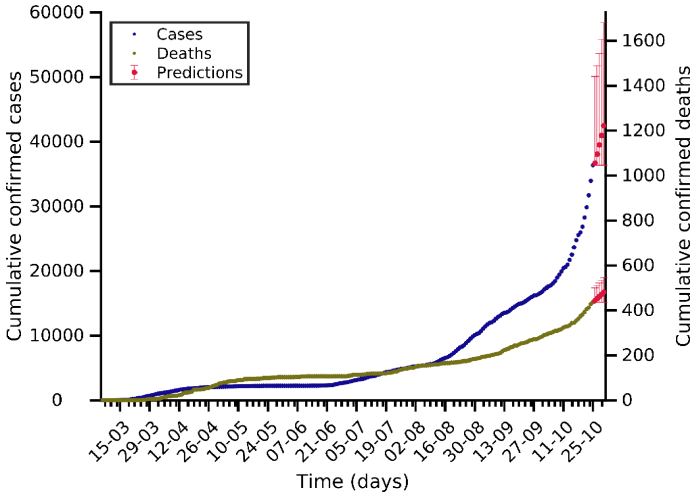








Croatia 25-10-2020. Pop: 4.1M. Cumulative incidence: 886/10⁵

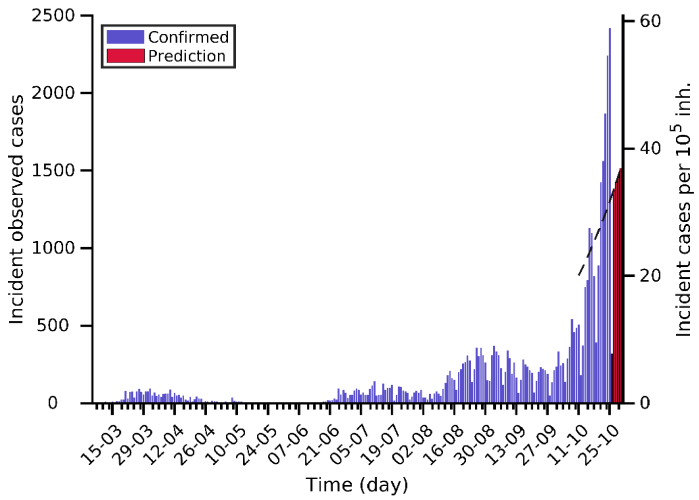


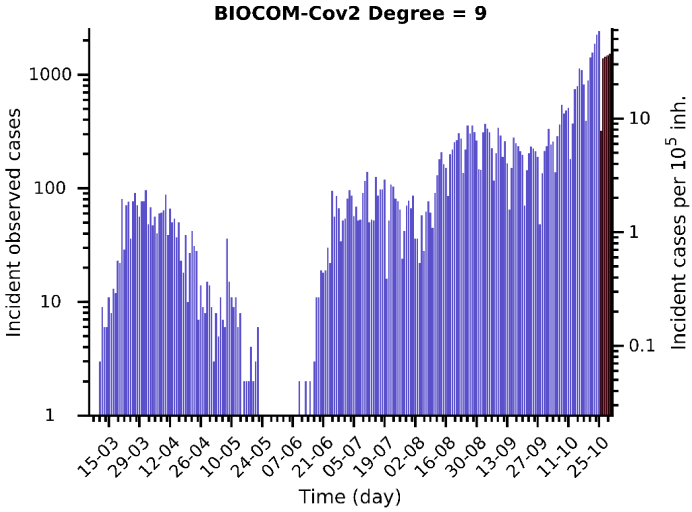
Predictions for next days

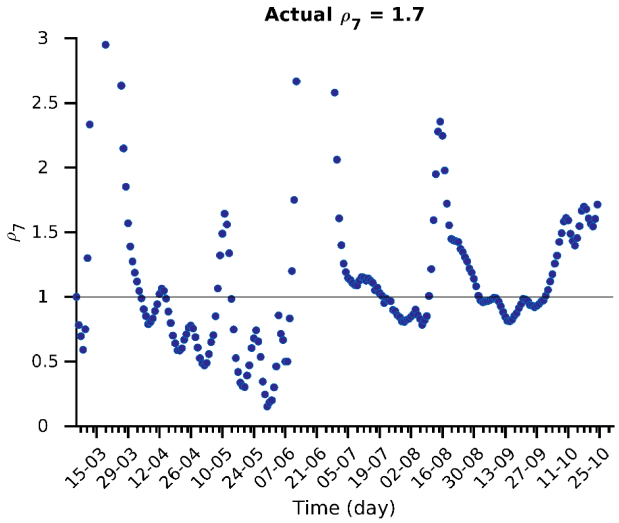
Day	Number of cases	95% Confidence Interval
26-10-2020	36697 (+317)	[36380 - 50104]
28-10-2020	39506 (+1426)	[36380 - 53654]
30-10-2020	42490 (+1514)	[36380 - 58443]

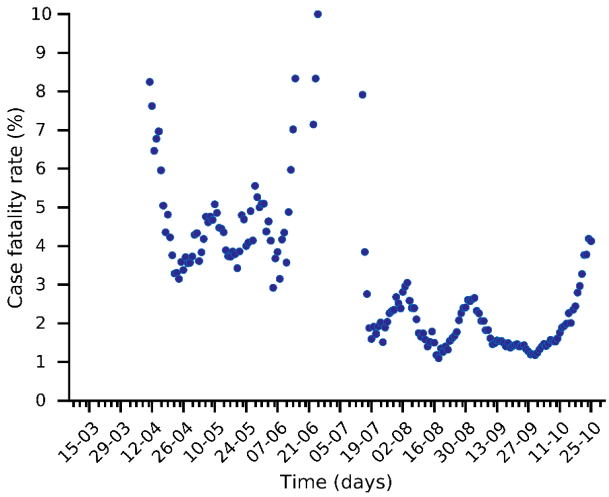
Current indicators

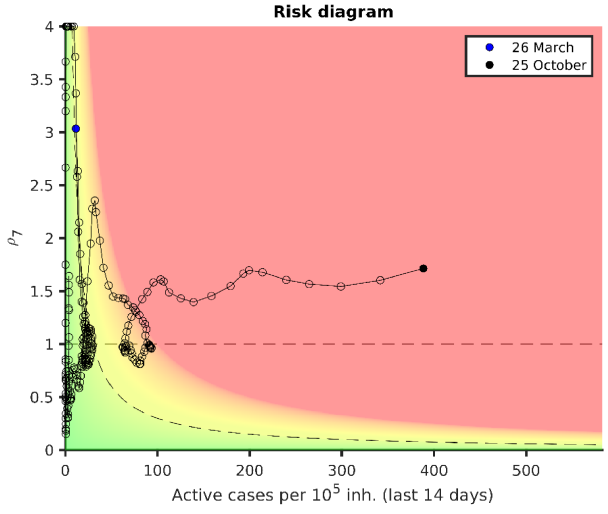
A_{14}	EPG	CFR
388	666	4.13 %

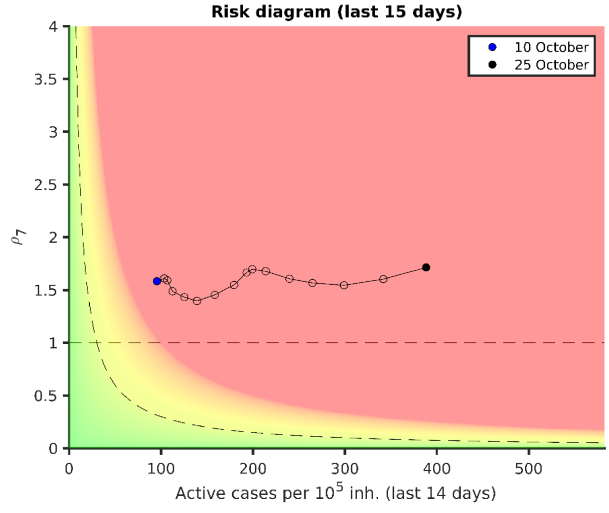




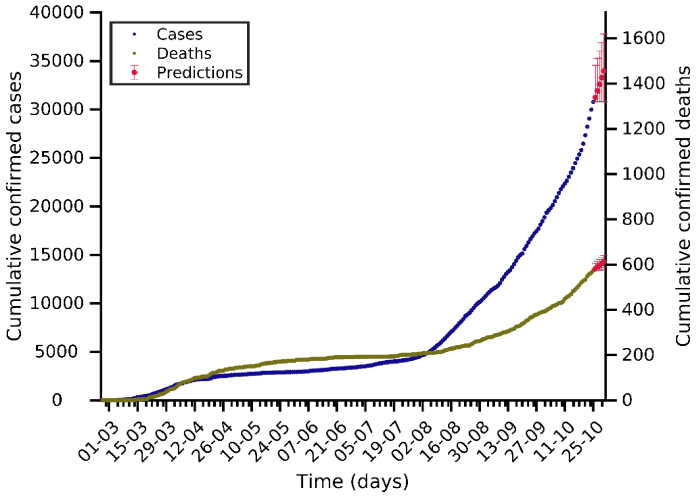








Greece 25-10-2020. Pop: 10.4M. Cumulative incidence: 295/10^5

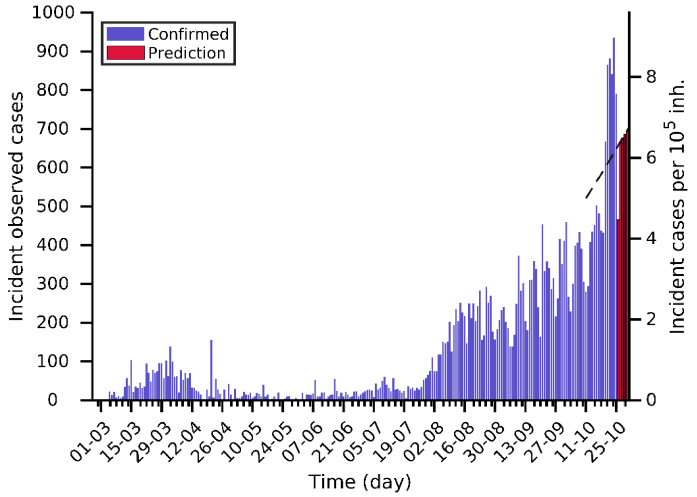


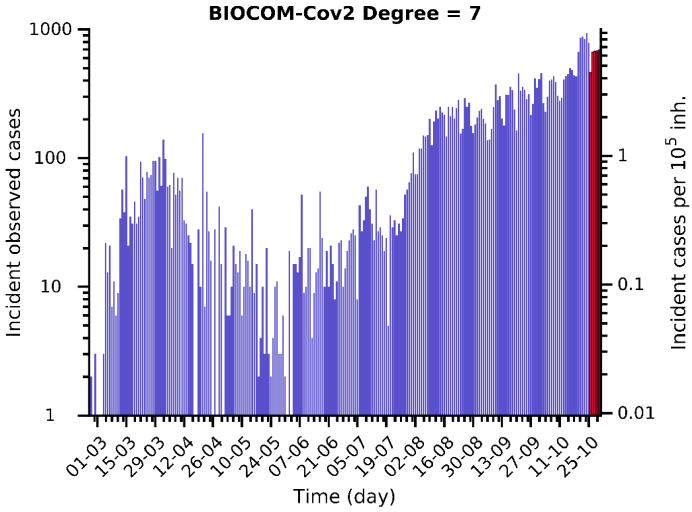
Predictions for next days

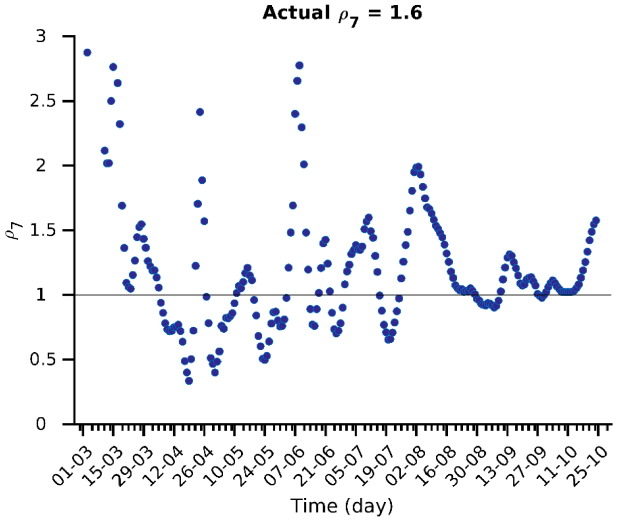
Day	Number of cases	95% Confidence Interval
26-10-2020	31248 (+466)	[30782 - 34550]
28-10-2020	32592 (+677)	[30782 - 36047]
30-10-2020	33975 (+696)	[30782 - 37781]

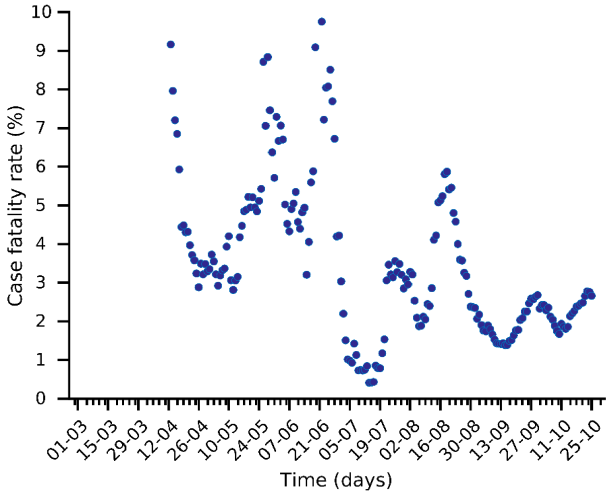
Current indicators

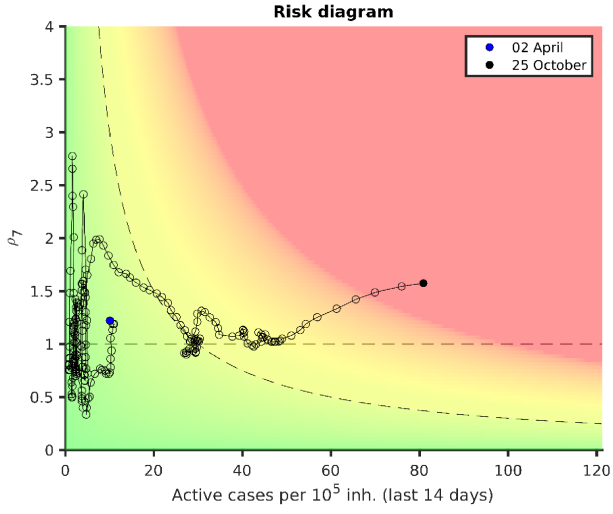
A_{14}	EPG	CFR
81	127	2.66 %

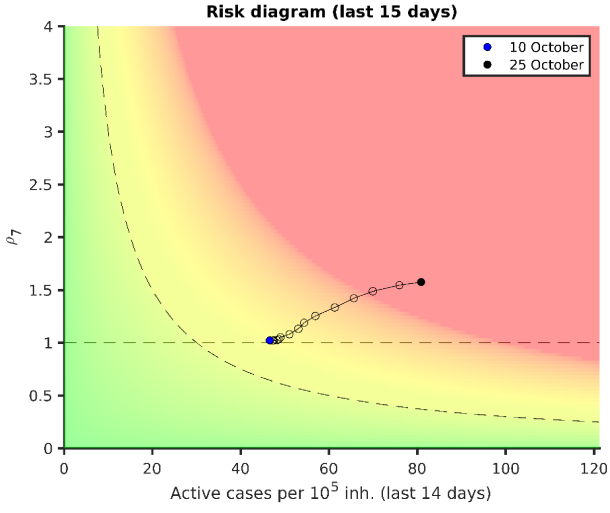




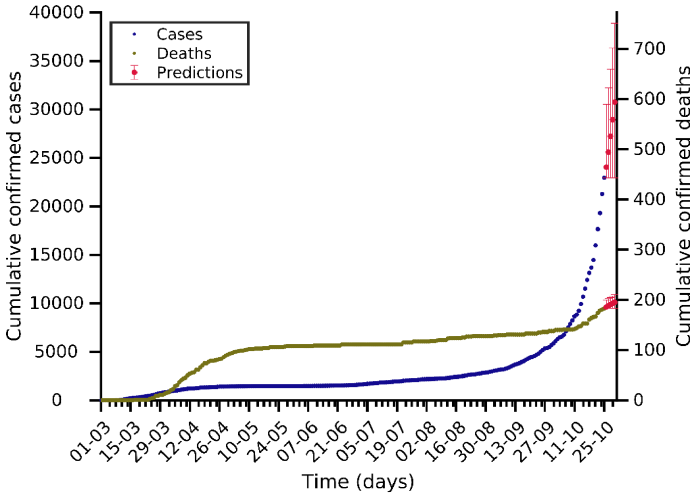








Slovenia 25-10-2020. Pop: 2.1M. Cumulative incidence: 1104/10^5

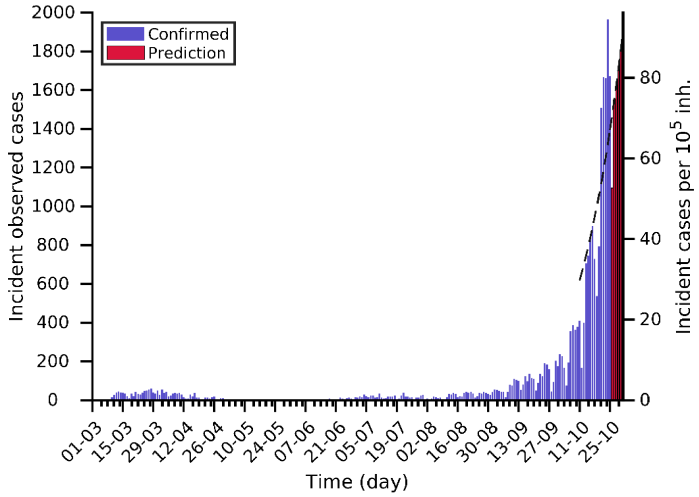


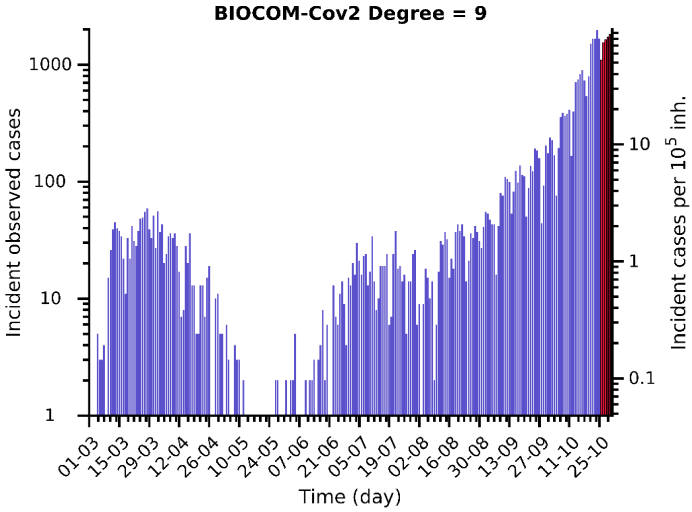
Predictions for next days

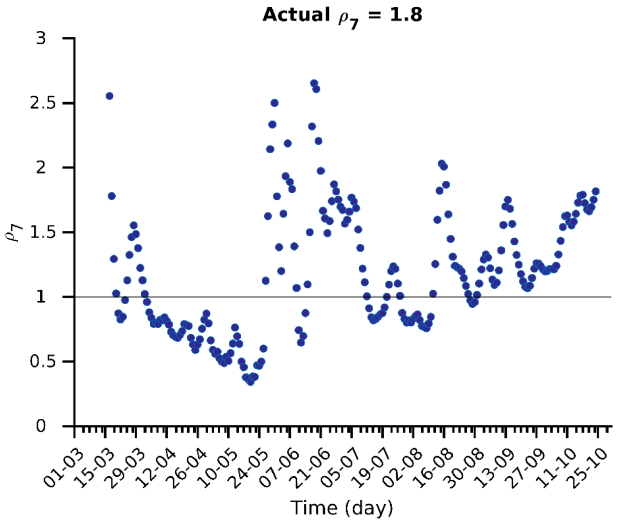
Day	Number of cases	95% Confidence Interval
26-10-2020	24045 (+1095)	[22950 - 30525]
28-10-2020	27226 (+1632)	[22950 - 34158]
30-10-2020	30748 (+1805)	[22950 - 38877]

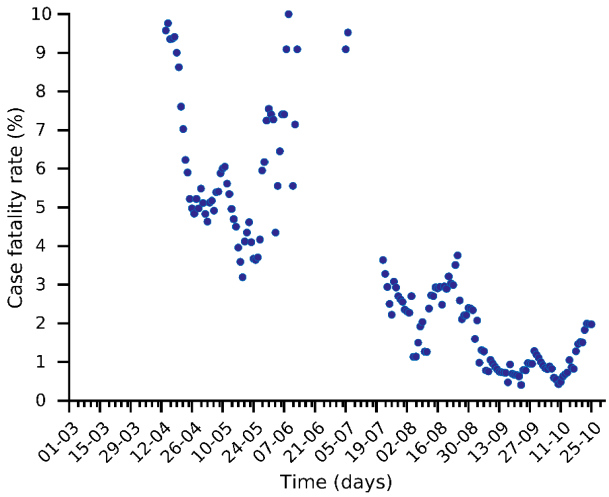
Current indicators

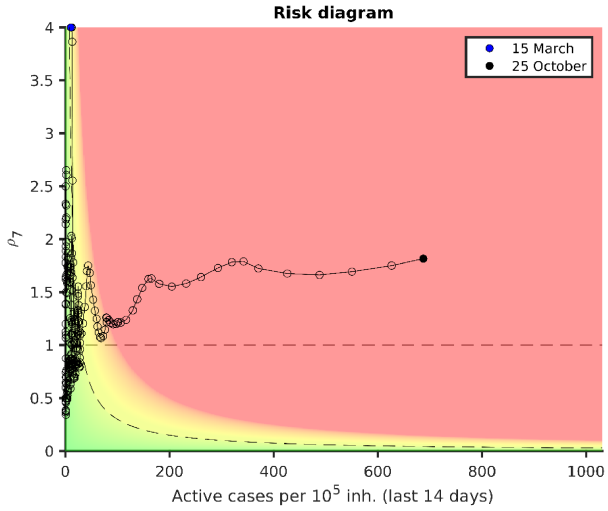
A_{14}	EPG	CFR
687	1248	1.97 %

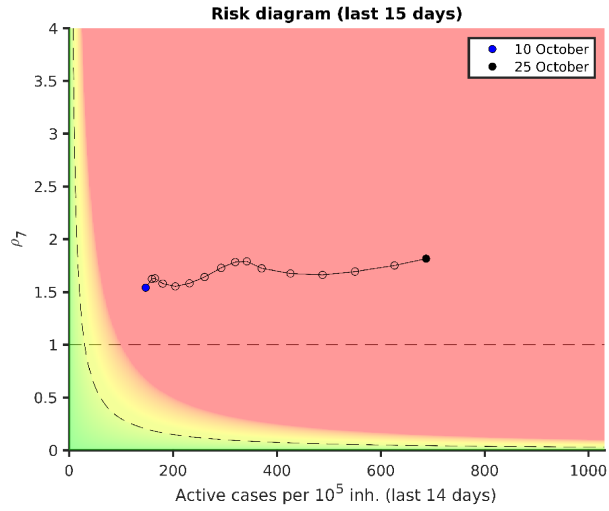




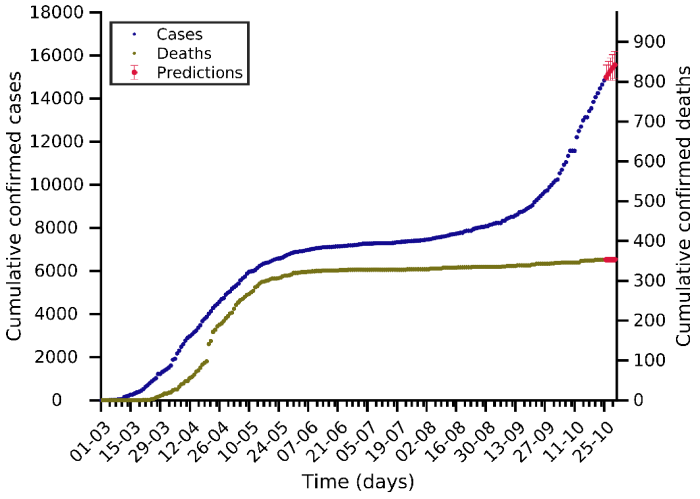








Finland 25-10-2020. Pop: 5.5M. Cumulative incidence: 268/10⁵

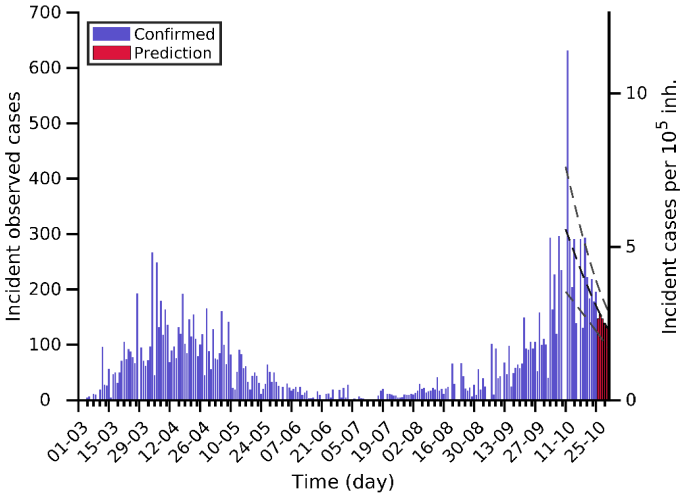


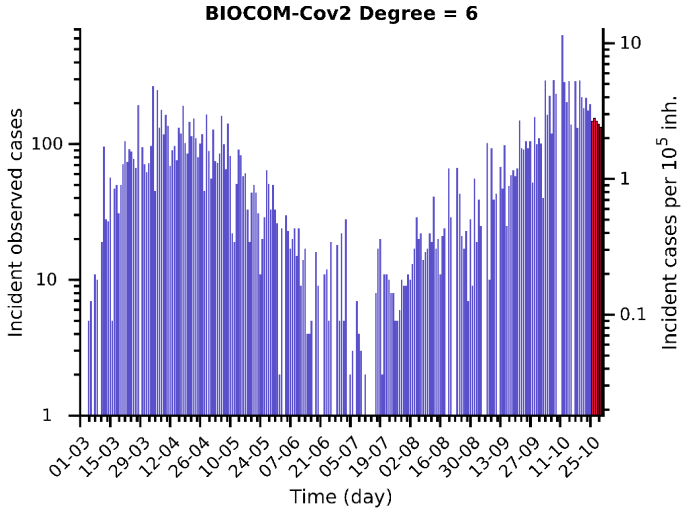
Predictions for next days

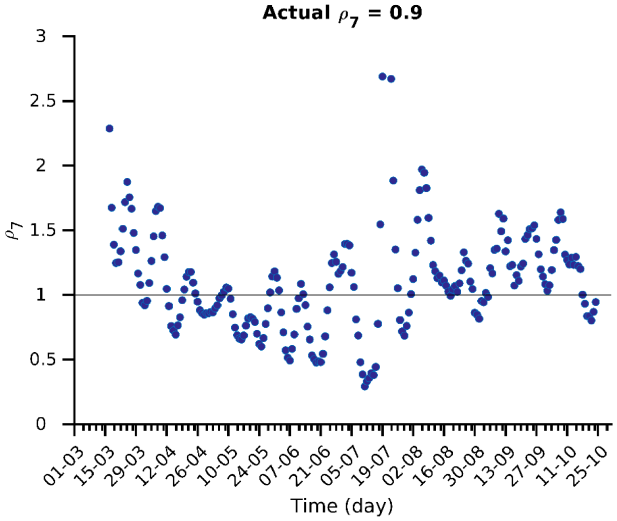
Day	Number of cases	95% Confidence Interval
26-10-2020	14995 (+147)	[14848 - 15569]
28-10-2020	15297 (+147)	[14848 - 15887]
30-10-2020	15569 (+133)	[14950 - 16189]

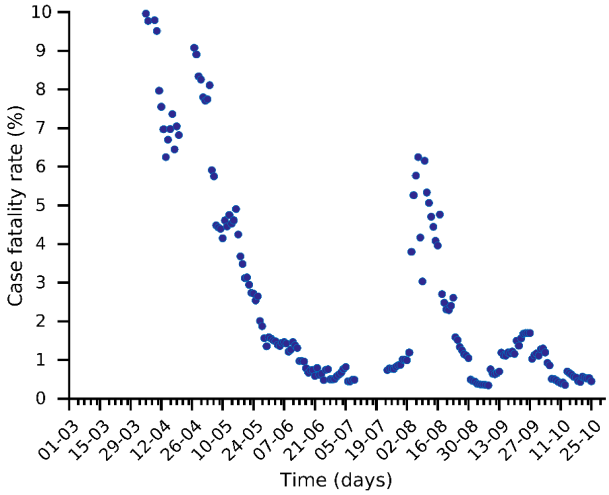
Current indicators

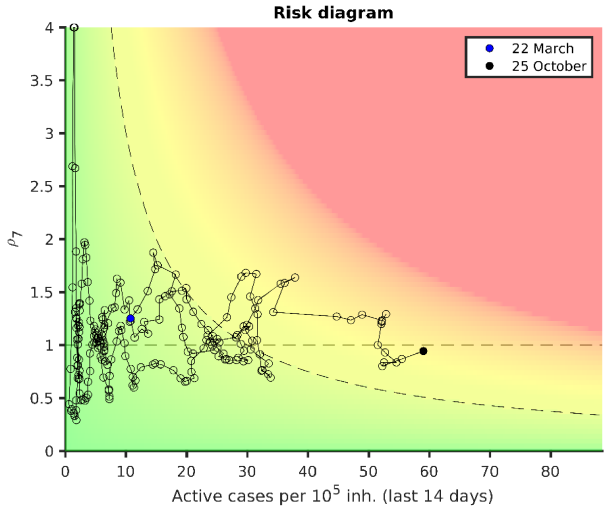
A_{14}	EPG	CFR
59	56	0.45 %

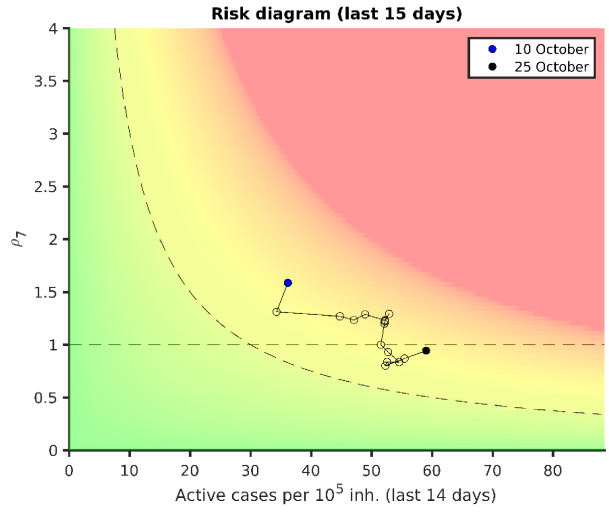




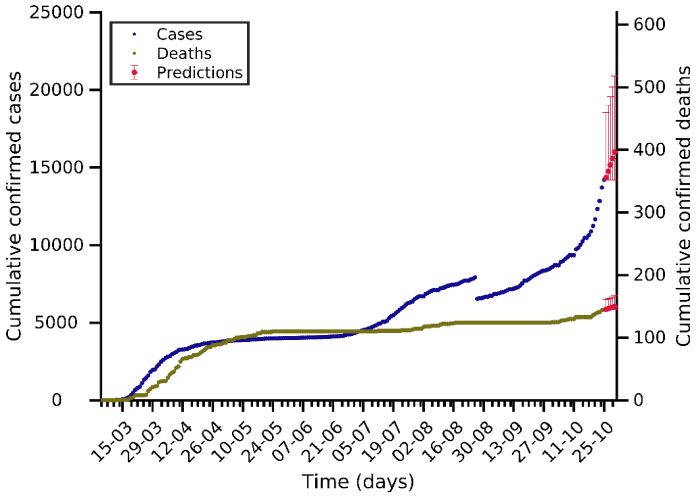








Luxembourg 25-10-2020. Pop: 0.6M. Cumulative incidence: 2269/10^5

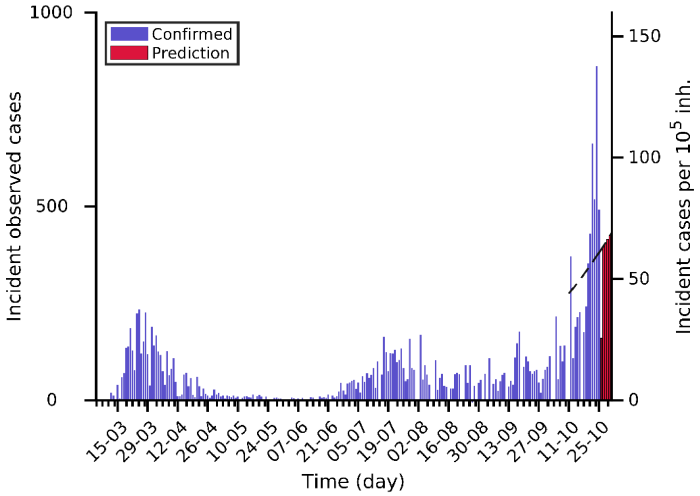


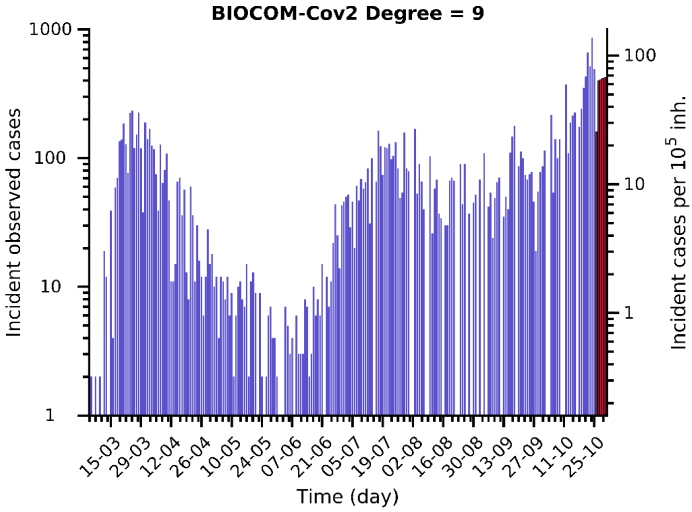
Predictions for next days

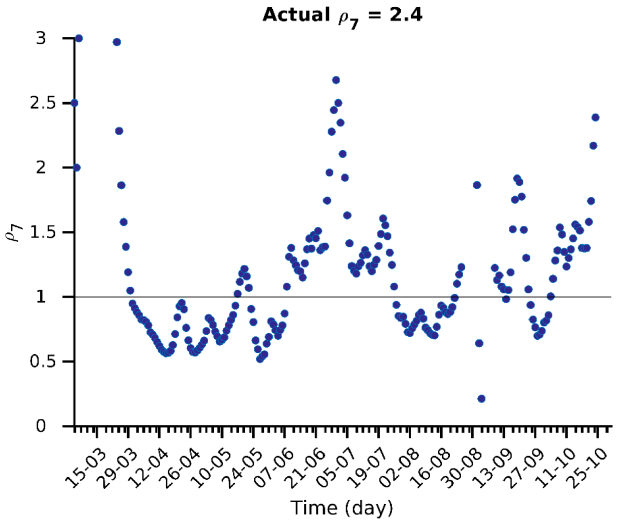
Day	Number of cases	95% Confidence Interval
26-10-2020	14364 (+160)	[14204 - 18555]
28-10-2020	15167 (+406)	[14204 - 19569]
30-10-2020	16006 (+424)	[14204 - 20902]

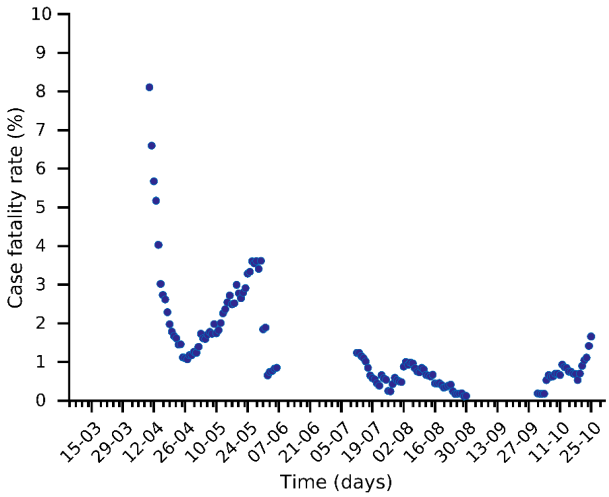
Current indicators

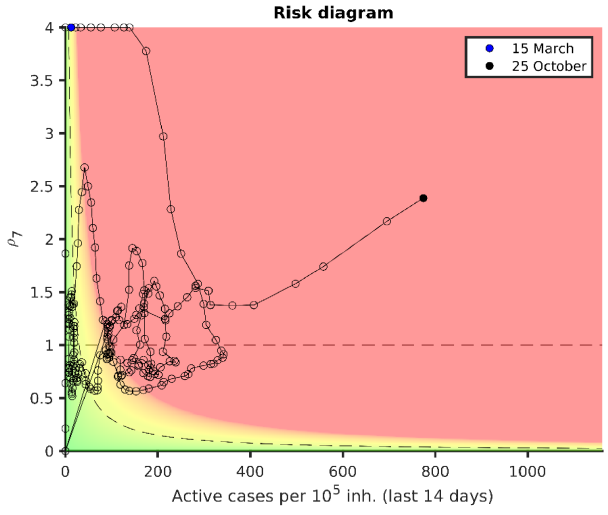
A_{14}	EPG	CFR
774	1848	1.66 %

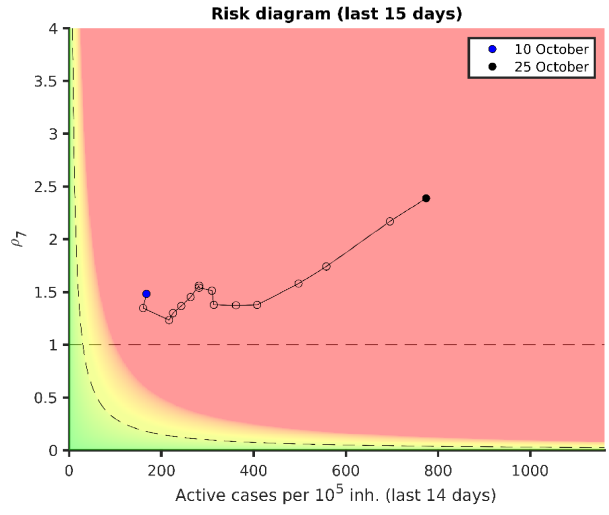




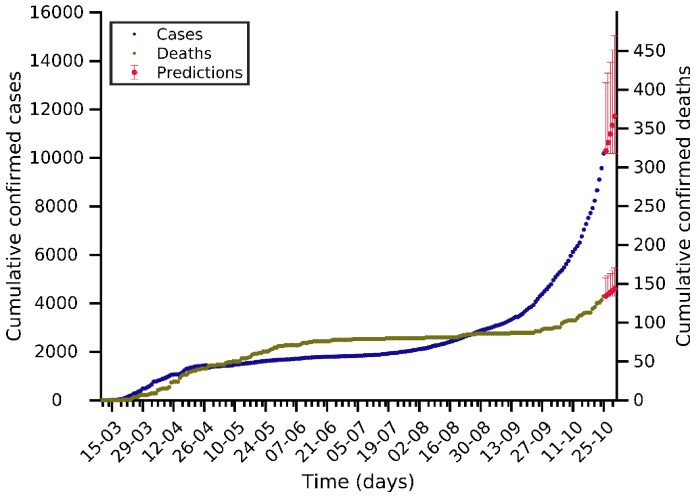








Lithuania 25-10-2020. Pop: 2.7M. Cumulative incidence: 374/10⁵

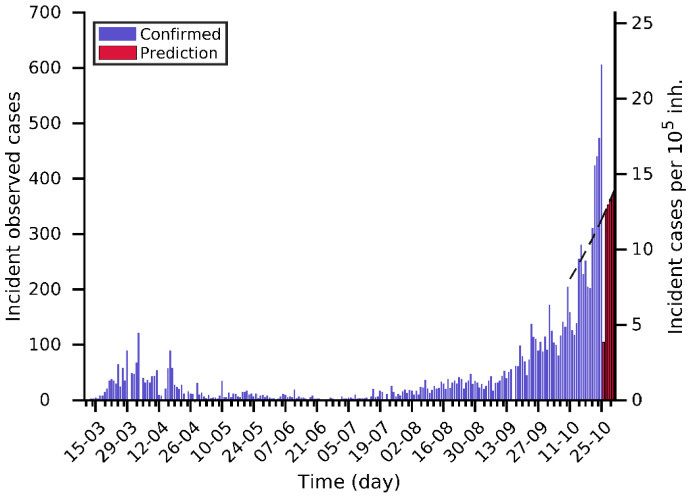


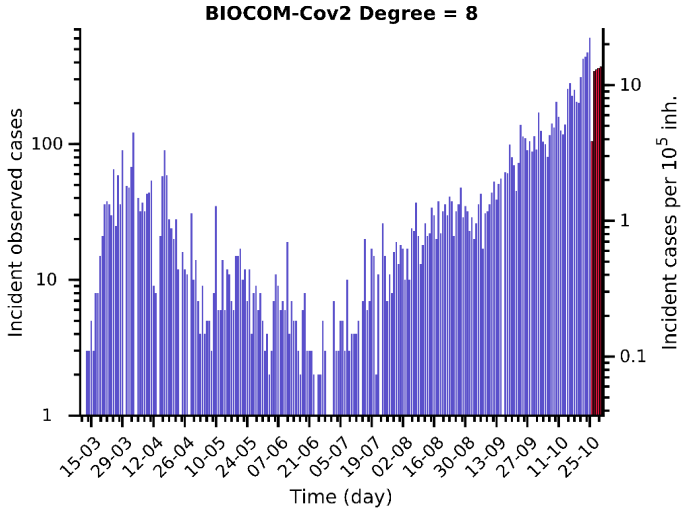
Predictions for next days

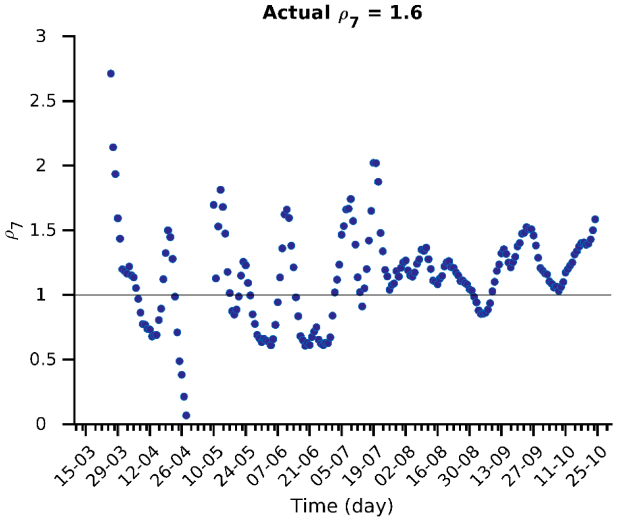
Day	Number of cases	95% Confidence Interval
26-10-2020	10288 (+104)	[10184 - 13104]
28-10-2020	10985 (+353)	[10184 - 13950]
30-10-2020	11719 (+372)	[10184 - 15042]

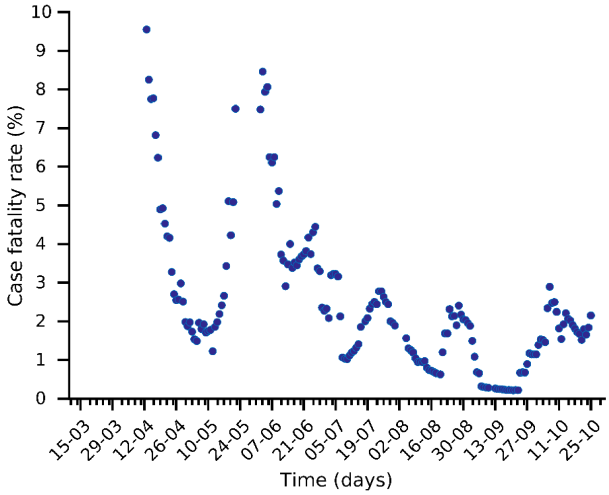
Current indicators

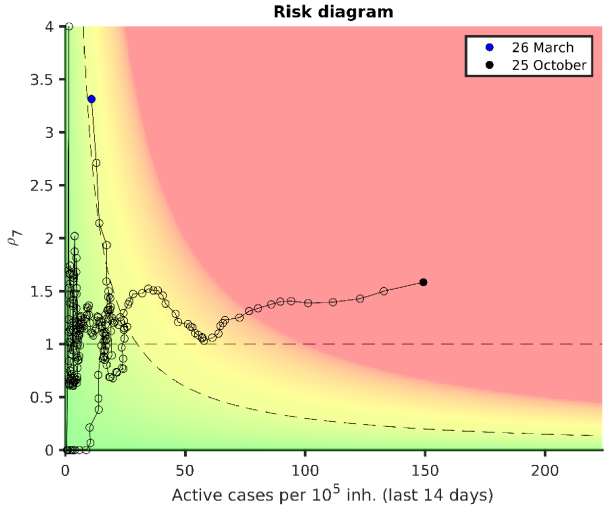
A_{14}	EPG	CFR
149	236	2.15 %

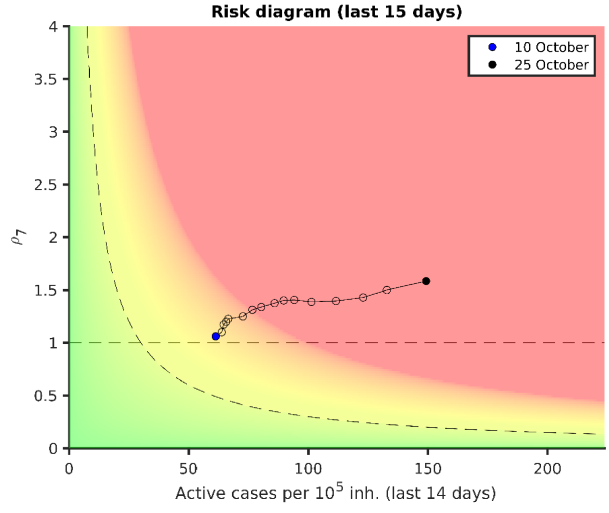




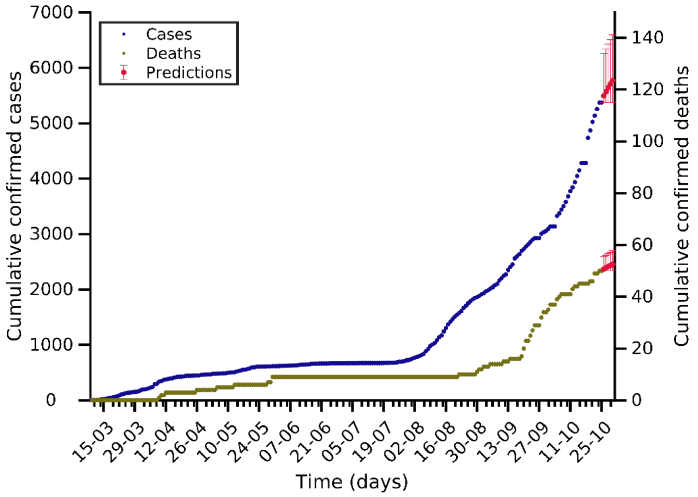








Malta 25-10-2020. Pop: 0.4M. Cumulative incidence: 1217/10⁵

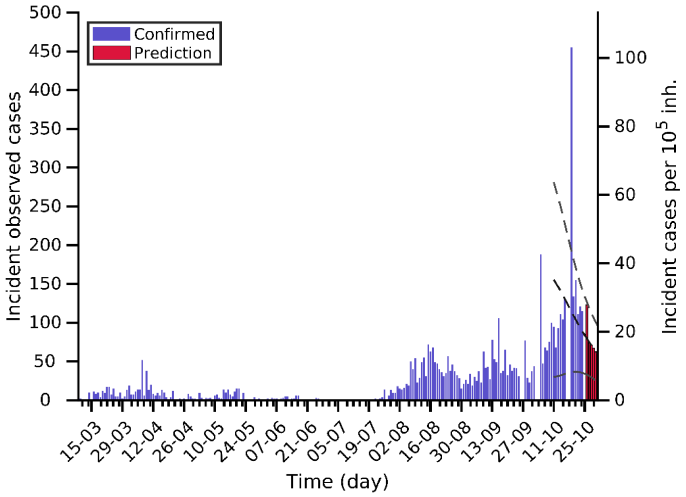


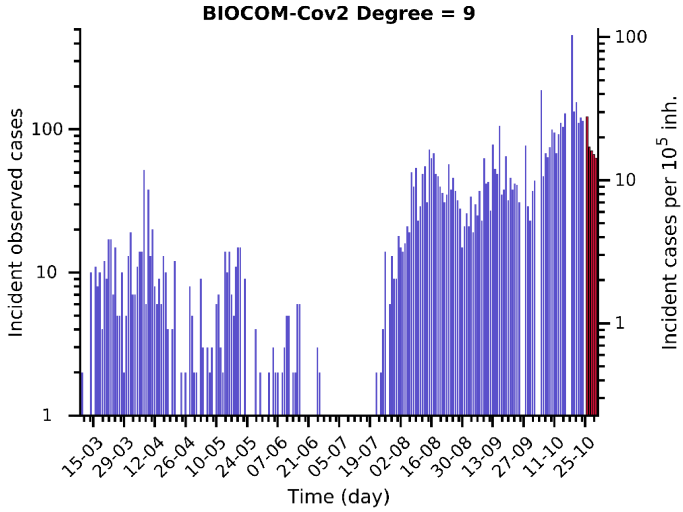
Predictions for next days

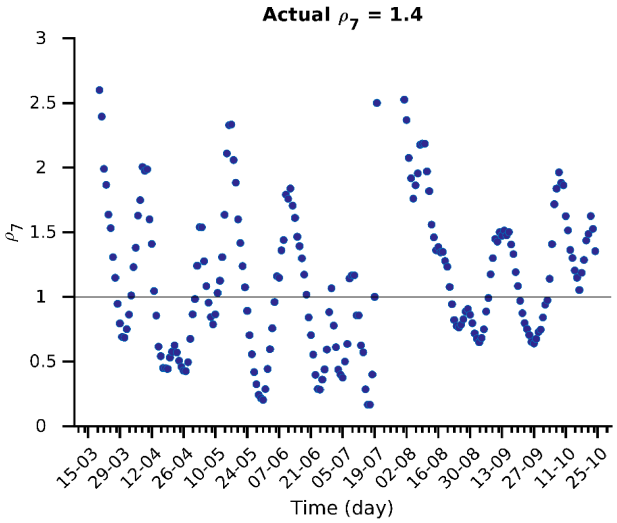
Day	Number of cases	95% Confidence Interval
26-10-2020	5496 (+123)	[5373 - 6261]
28-10-2020	5642 (+71)	[5373 - 6428]
30-10-2020	5772 (+63)	[5373 - 6595]

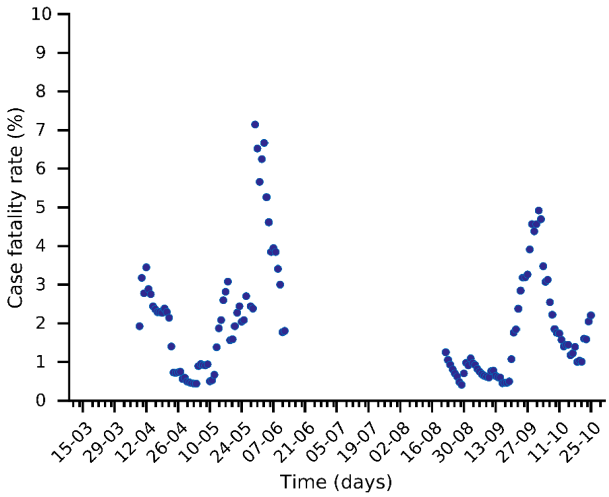
Current indicators

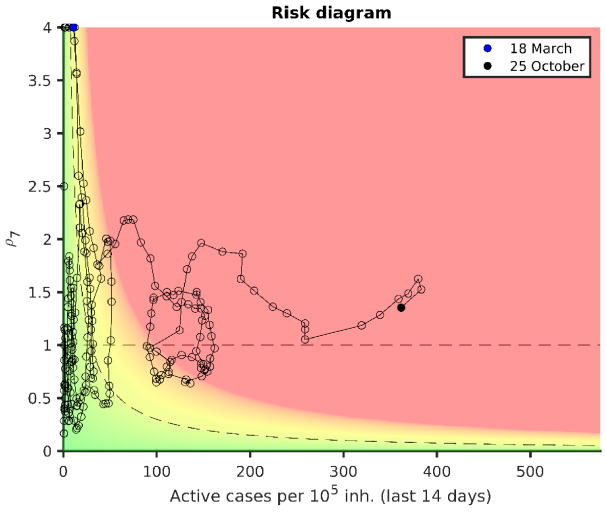
A_{14}	EPG	CFR
362	490	2.21 %

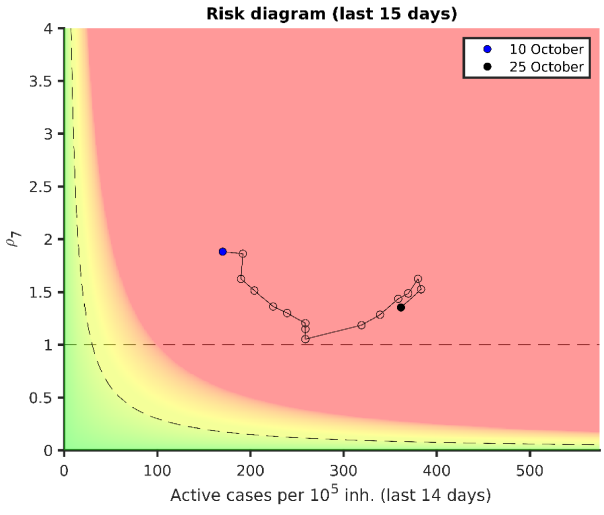




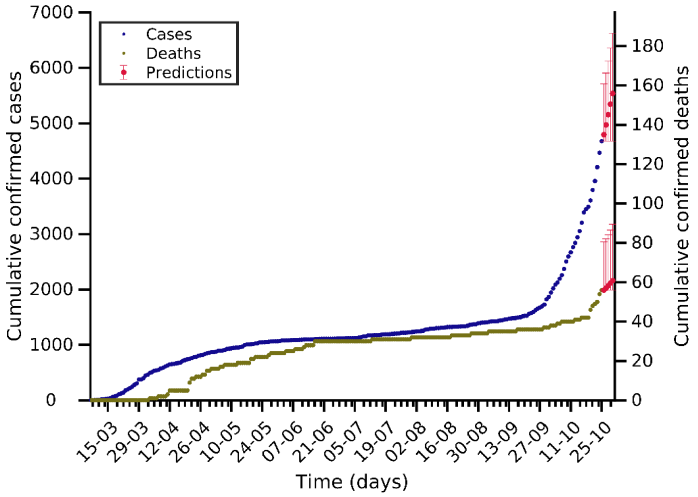








Latvia 25-10-2020. Pop: 1.9M. Cumulative incidence: 248/10^5

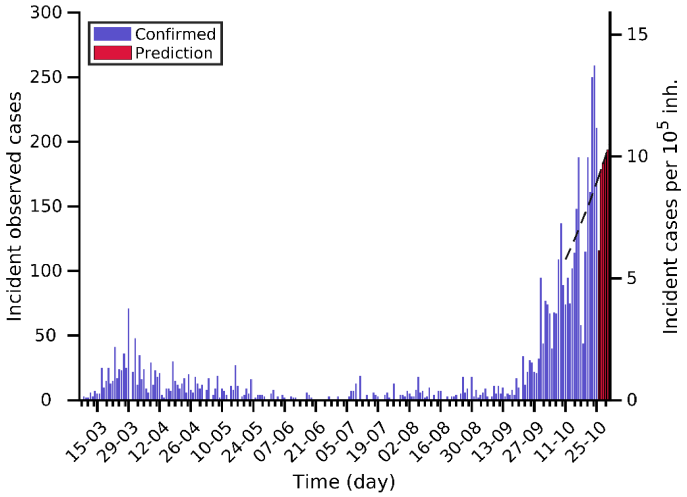


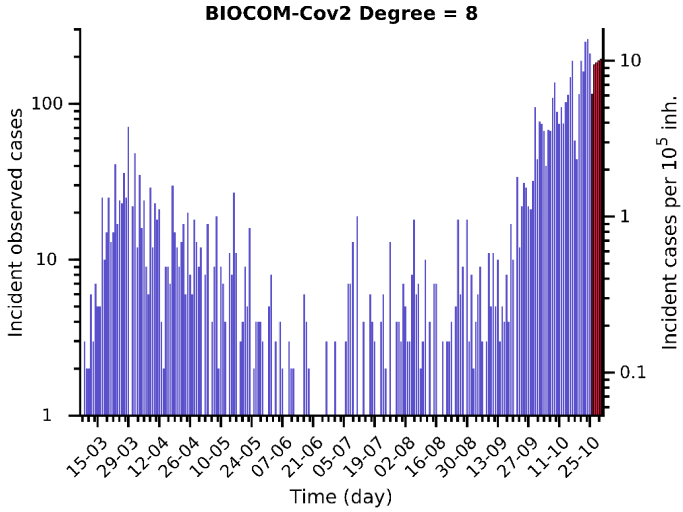
Predictions for next days

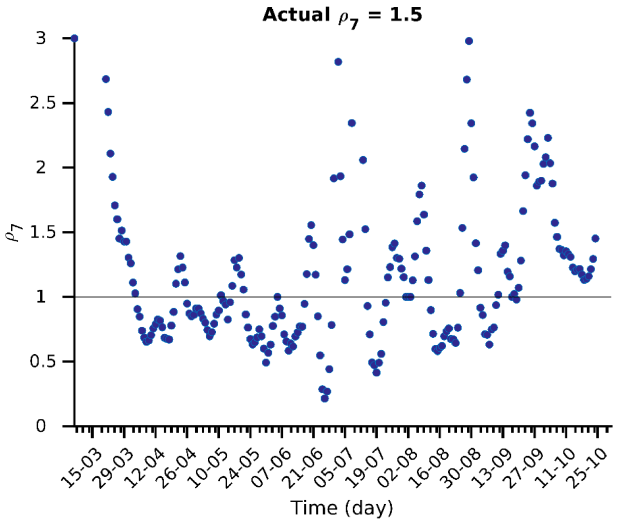
Day	Number of cases	95% Confidence Interval
26-10-2020	4794 (+116)	[4678 - 5711]
28-10-2020	5156 (+183)	[4678 - 6123]
30-10-2020	5538 (+194)	[4678 - 6627]

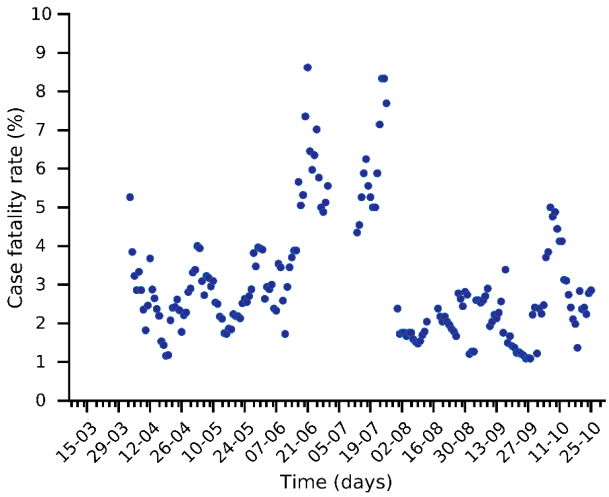
Current indicators

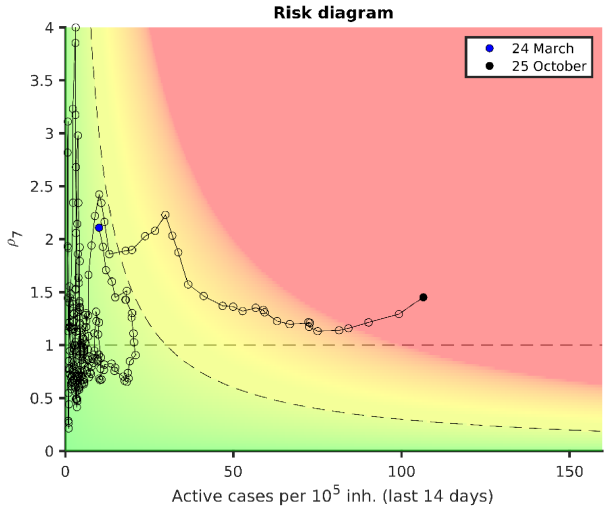
A_{14}	EPG	CFR
106	155	2.85 %

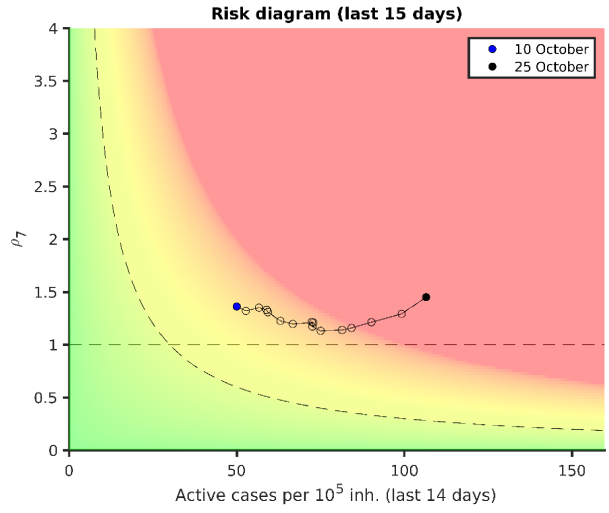




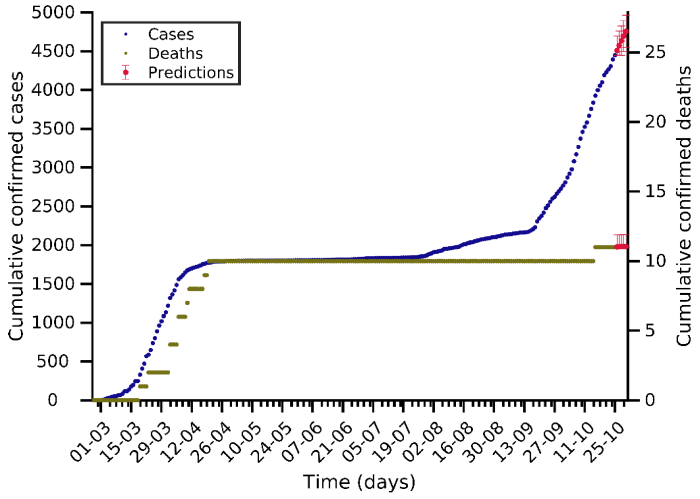








Iceland 25-10-2020. Pop: 0.3M. Cumulative incidence: 1303/10^5

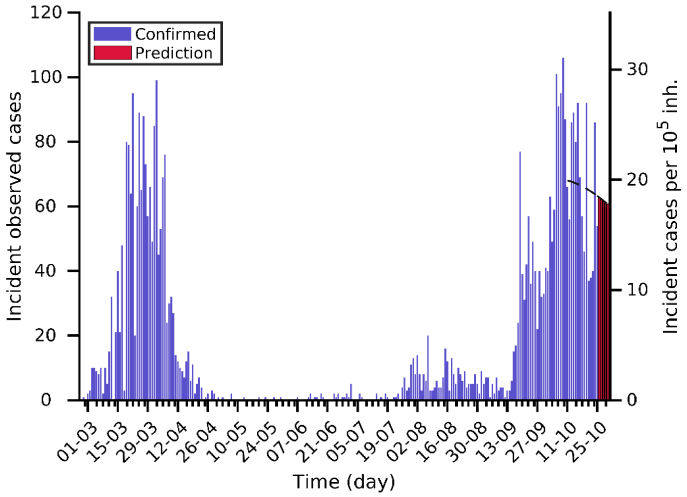


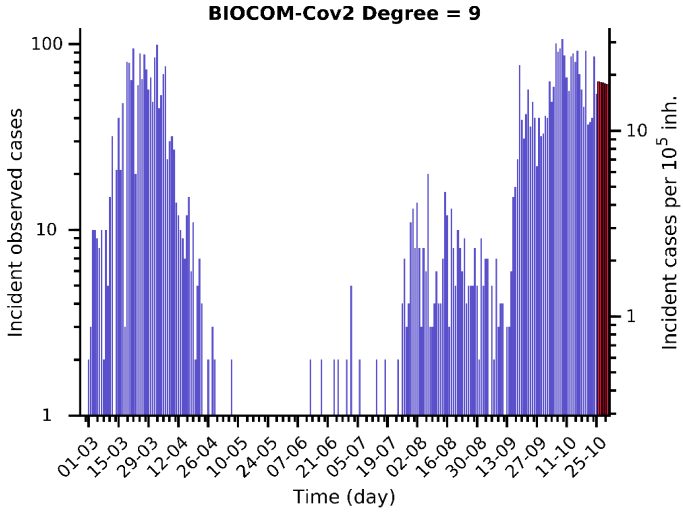
Predictions for next days

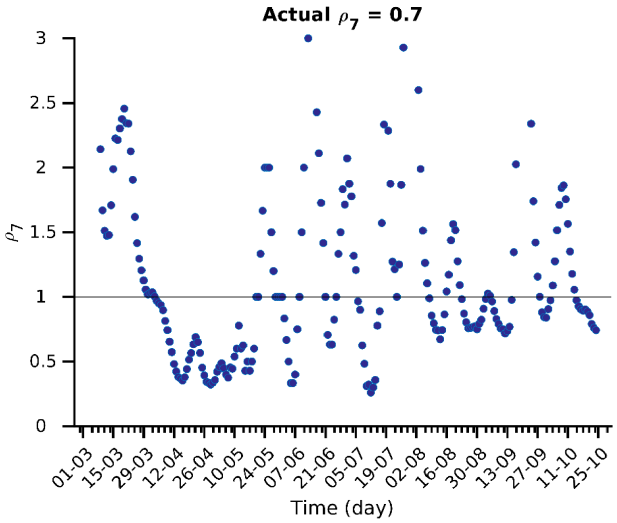
Day	Number of cases	95% Confidence Interval
26-10-2020	4511 (+63)	[4448 - 4696]
28-10-2020	4635 (+62)	[4448 - 4827]
30-10-2020	4757 (+61)	[4549 - 4964]

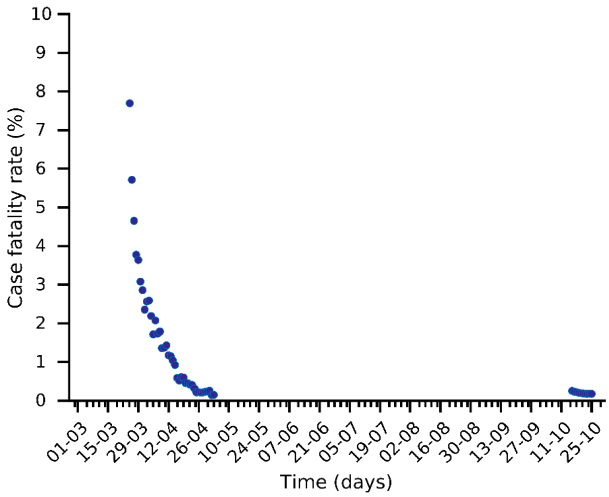
Current indicators

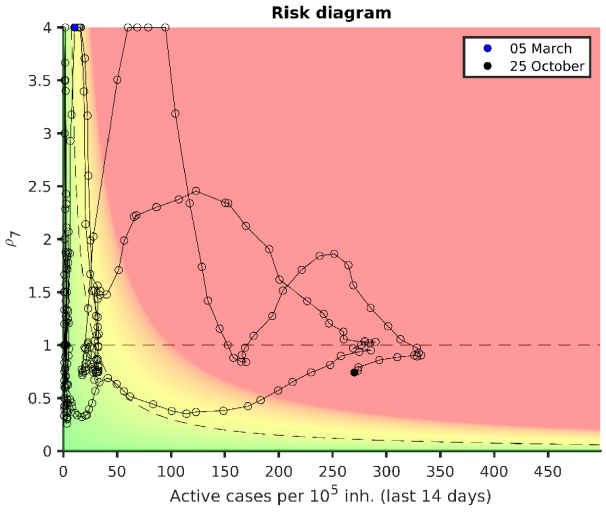
A_{14}	EPG	CFR
270	201	0.17 %

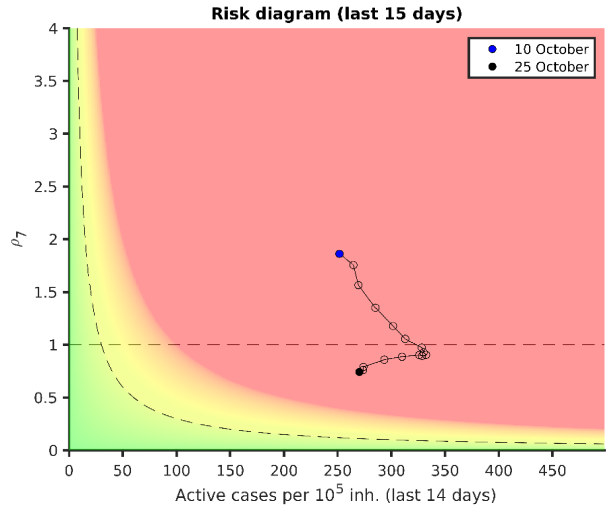




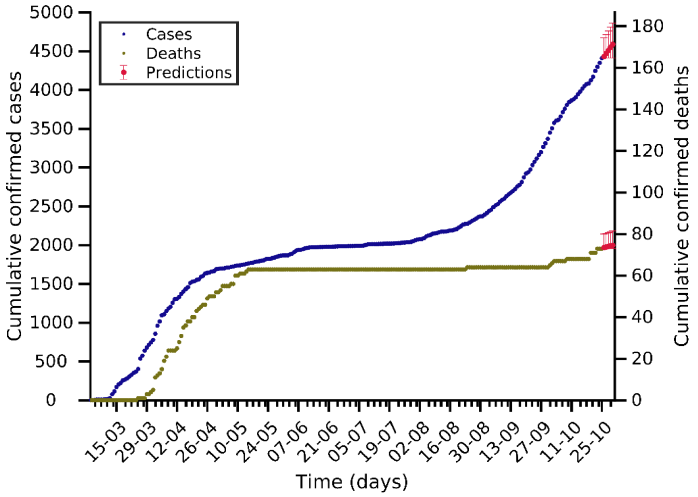








Estonia 25-10-2020. Pop: 1.3M. Cumulative incidence: 333/10⁵

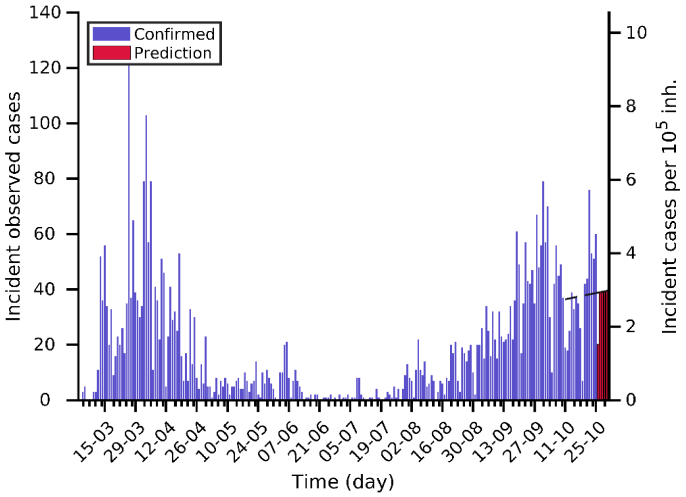


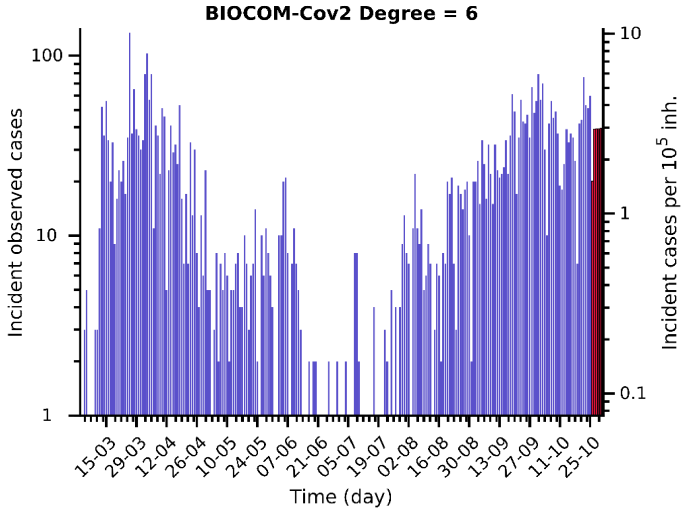
Predictions for next days

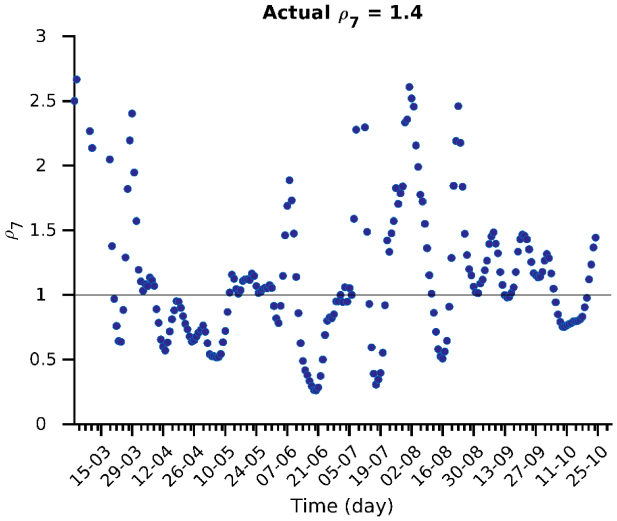
Day	Number of cases	95% Confidence Interval
26-10-2020	4431 (+20)	[4411 - 4674]
28-10-2020	4509 (+39)	[4411 - 4762]
30-10-2020	4588 (+39)	[4411 - 4863]

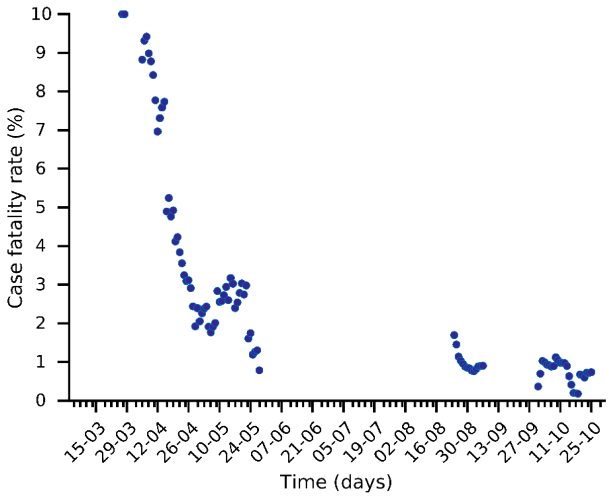
Current indicators

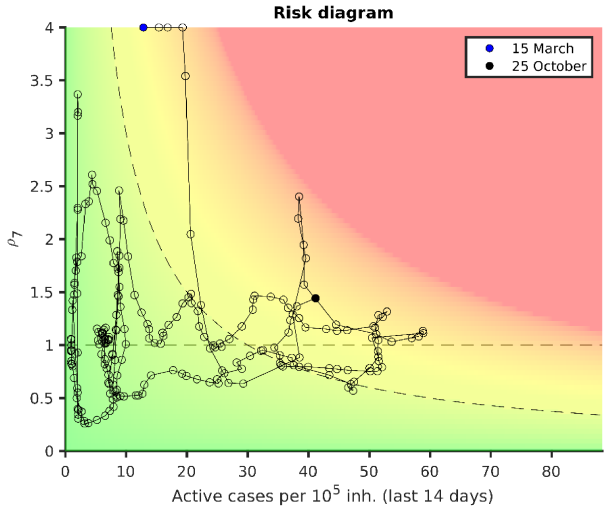
A_{14}	EPG	CFR
41	59	0.73 %

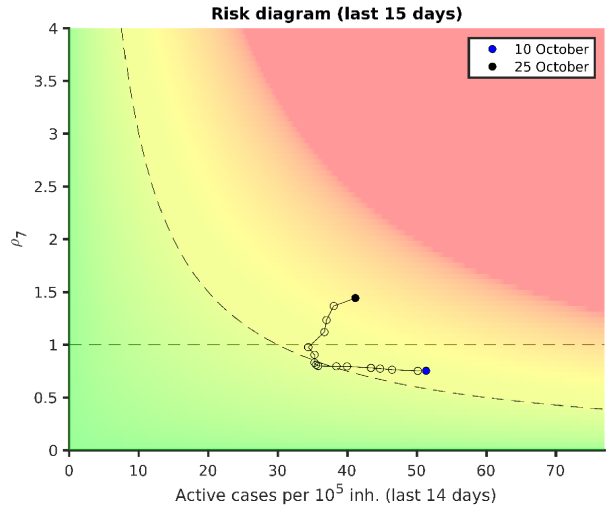




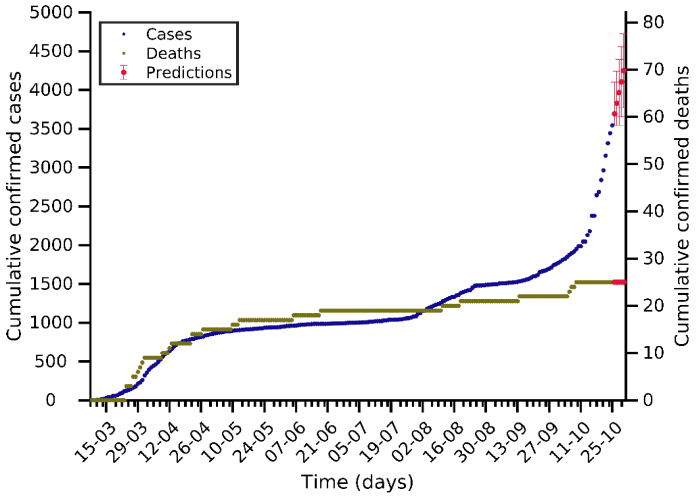








Cyprus 25-10-2020. Pop: 1.2M. Cumulative incidence: 294/10^5

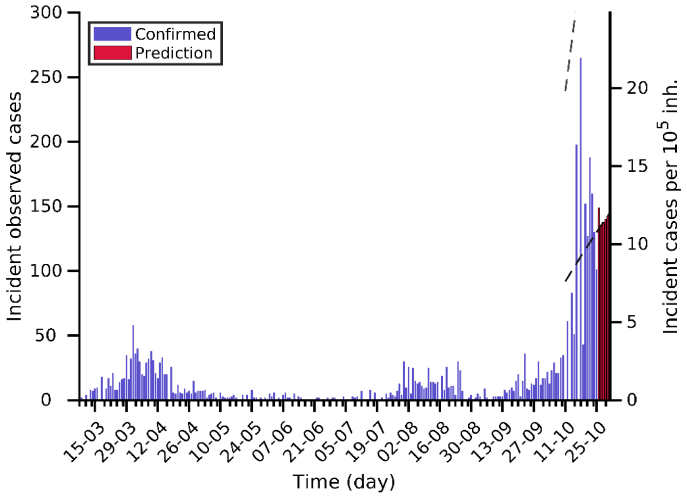


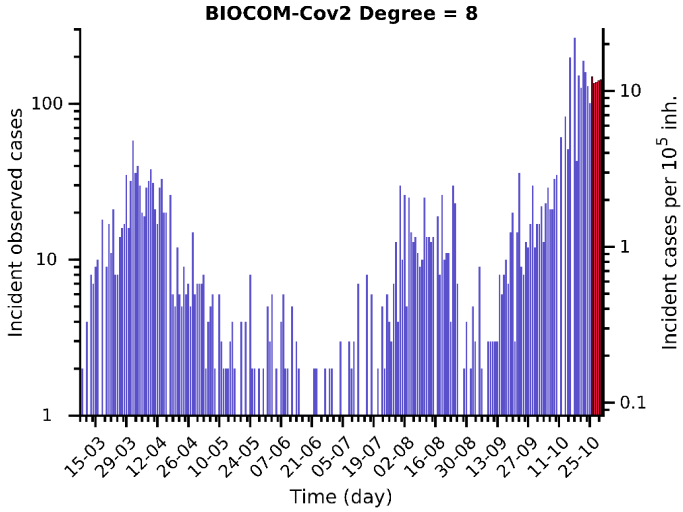
Predictions for next days

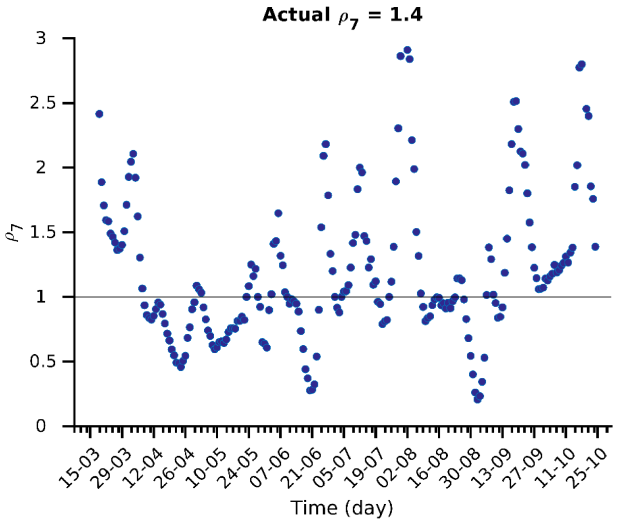
Day	Number of cases	95% Confidence Interval
26-10-2020	3694 (+149)	[3545 - 4102]
28-10-2020	3966 (+138)	[3545 - 4395]
30-10-2020	4249 (+143)	[3771 - 4727]

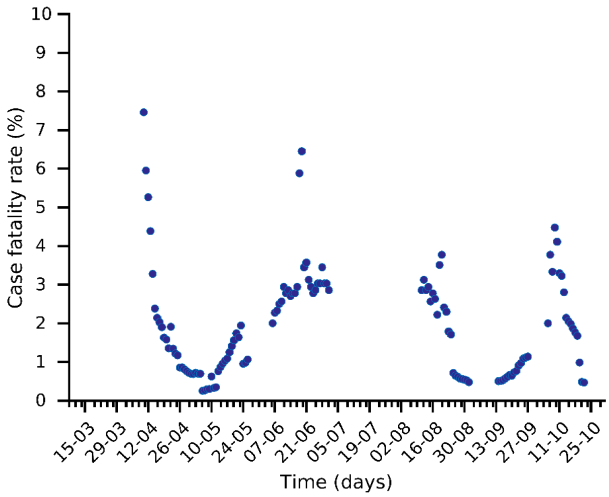
Current indicators

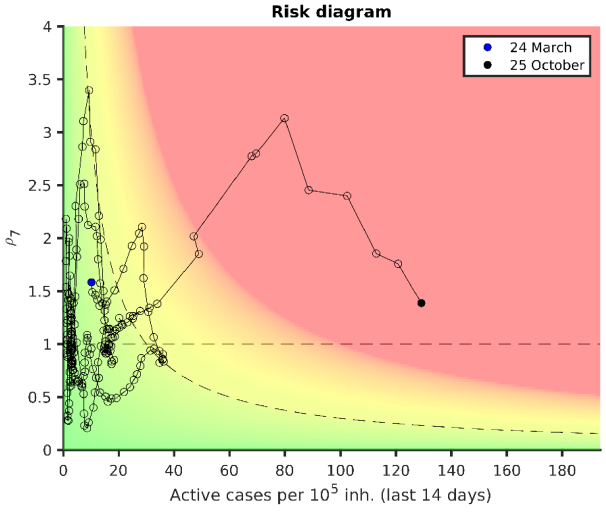
A_{14}	EPG	CFR
129	179	0.00 %

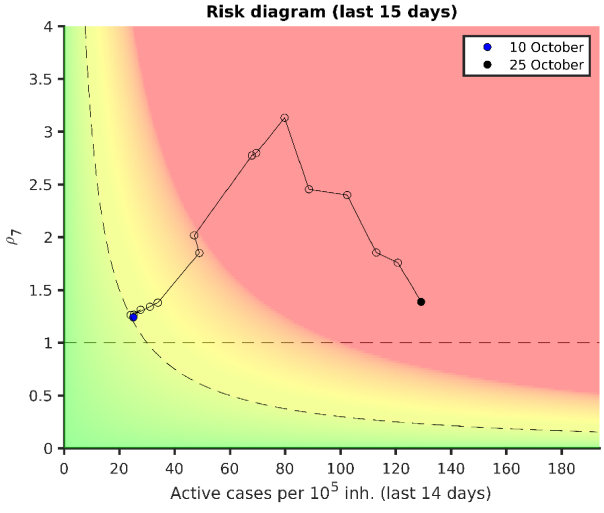






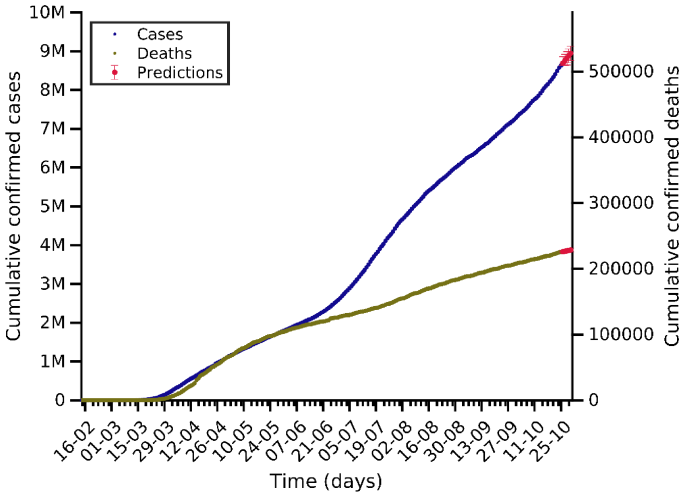






(2) Analysis and prediction of COVID-19 for other countries

USA 25-10-2020. Pop: 331.0M. Cumulative incidence: 2609/10⁵

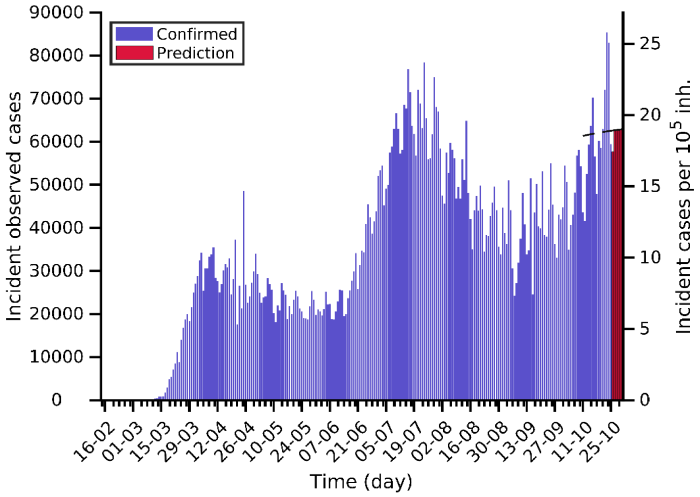


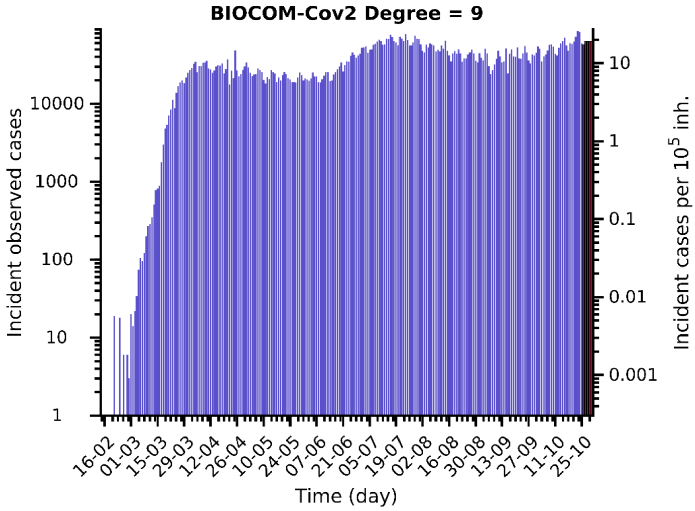
Predictions for next days

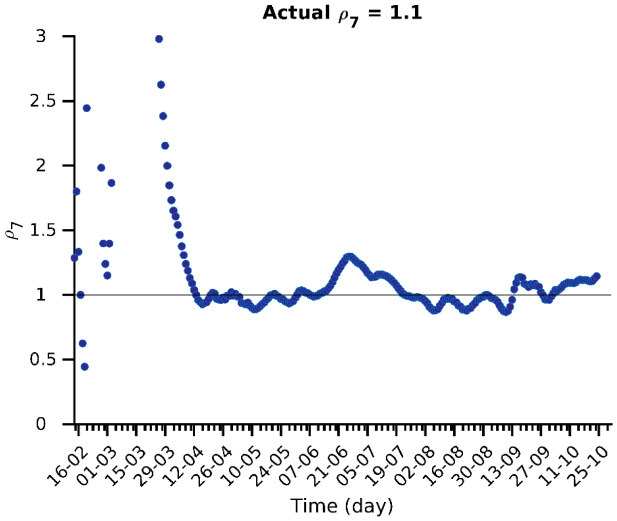
Day	Number of cases	95% Confidence Interval
26-10-2020	8693820 (+57655)	[8636165 - 8857392]
28-10-2020	8819270 (+62756)	[8649166 - 8989375]
30-10-2020	8944953 (+62869)	[8760788 - 9129117]

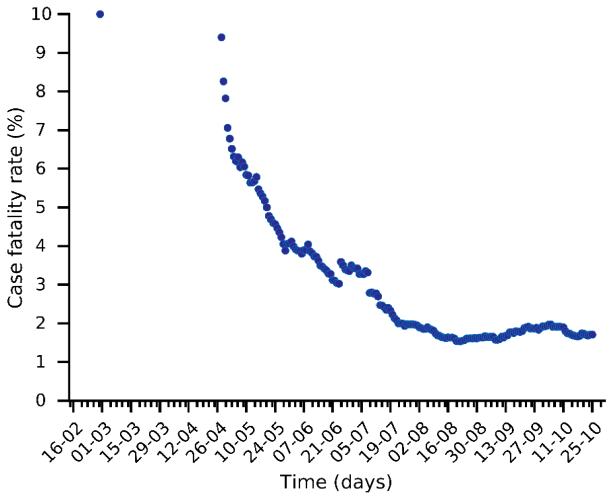
Current indicators

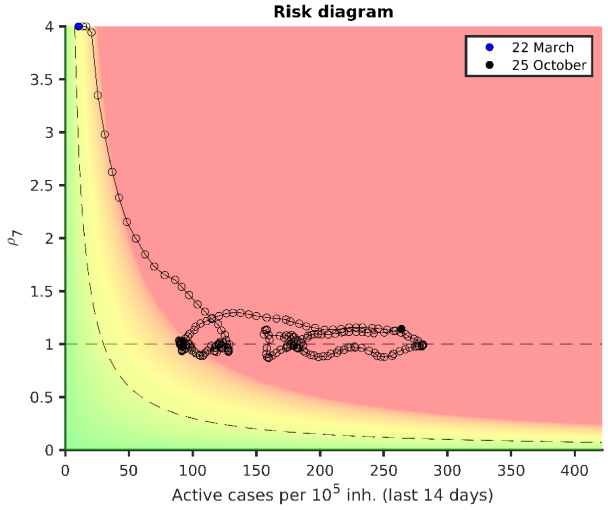
A_{14}	EPG	CFR
264	302	1.71 %

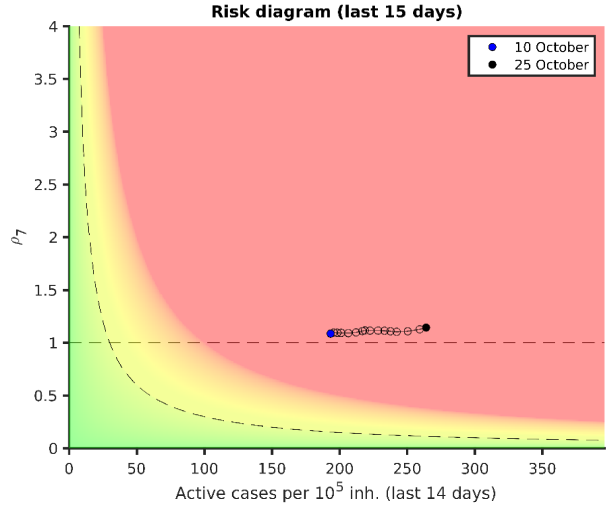




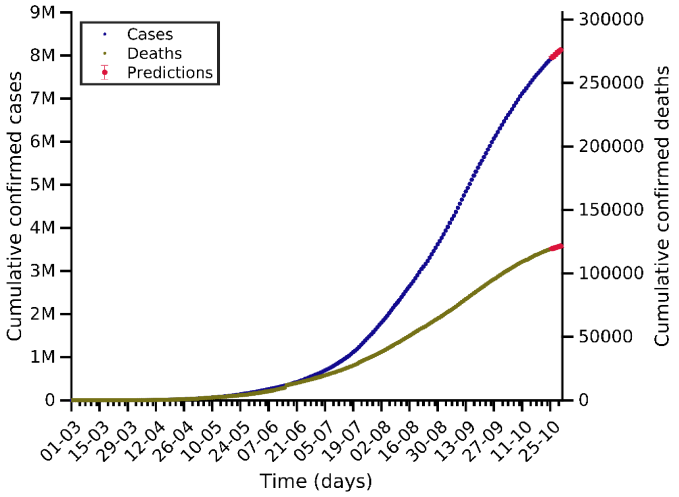








India 25-10-2020. Pop: 1353.0M. Cumulative incidence: 585/10⁵

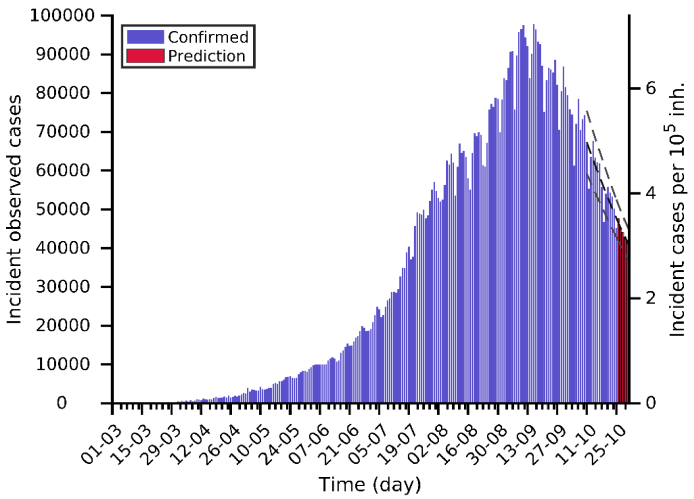


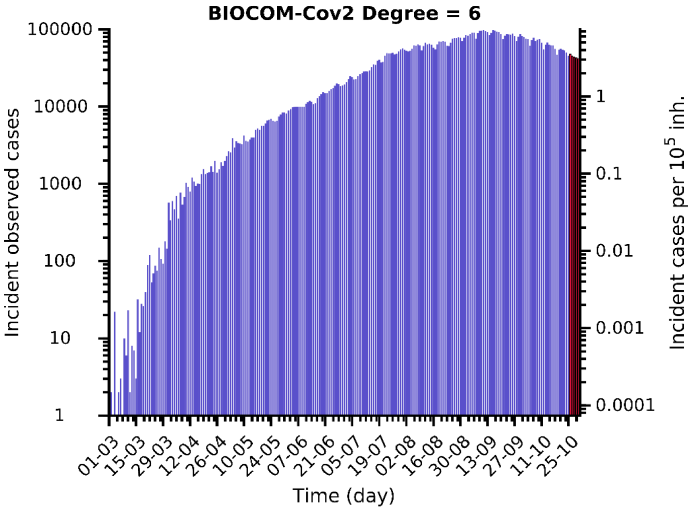
Predictions for next days

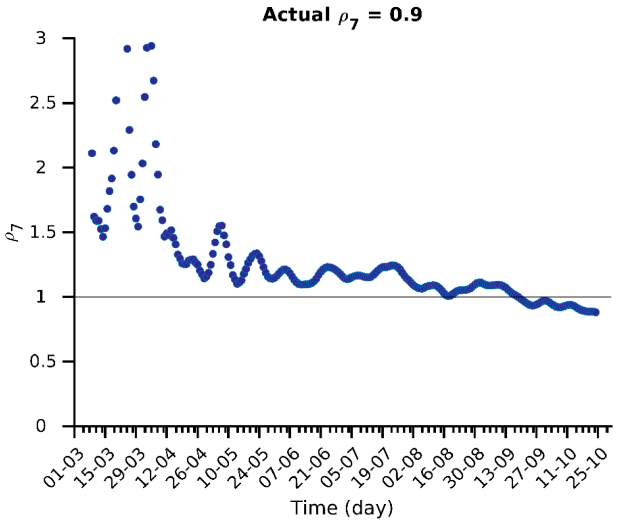
Day	Number of cases	95% Confidence Interval
26-10-2020	7957557 (+47598)	[7933407 - 7981707]
28-10-2020	8046786 (+44018)	[8021858 - 8071713]
30-10-2020	8131336 (+41702)	[8104876 - 8157796]

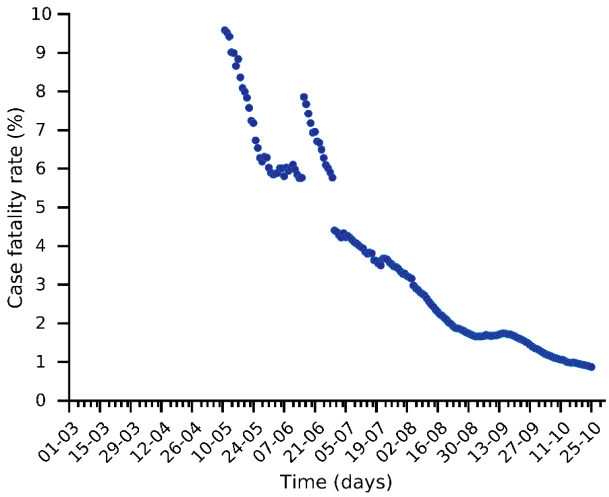
Current indicators

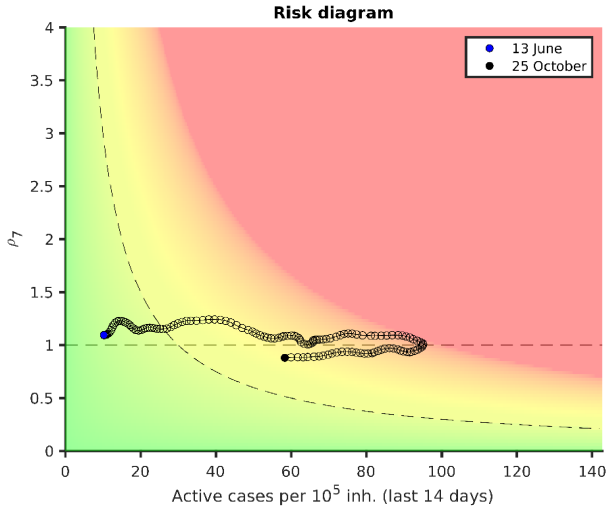
A_{14}	EPG	CFR
58	51	0.87 %

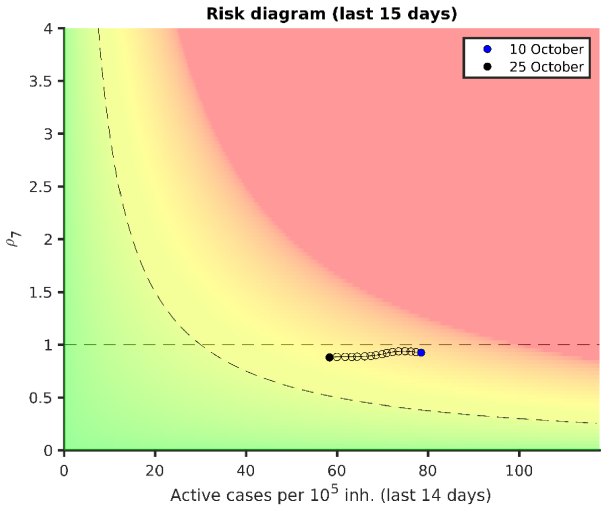




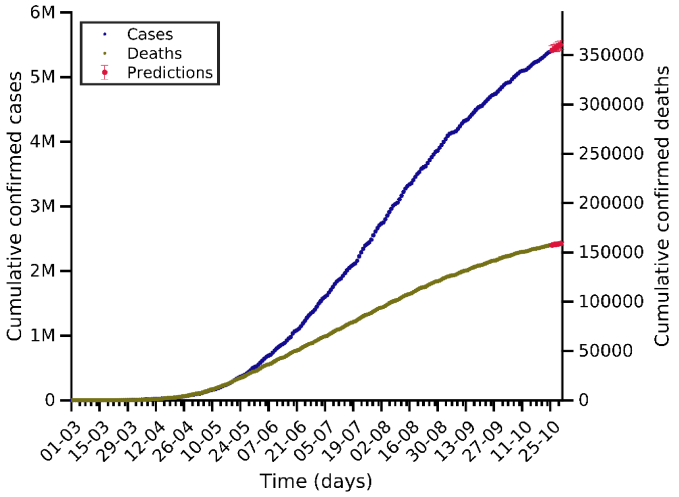








Brazil 25-10-2020. Pop: 212.6M. Cumulative incidence: 2538/10^5

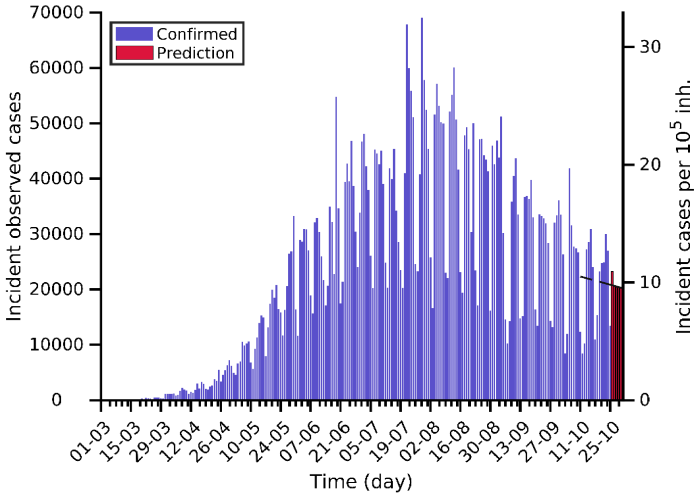


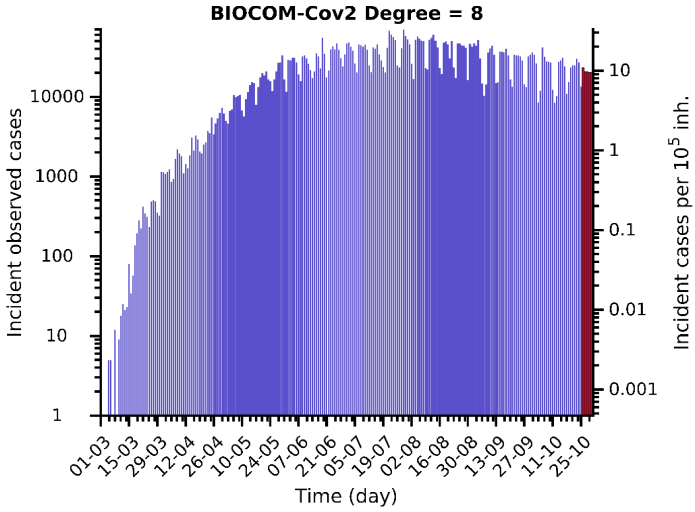
Predictions for next days

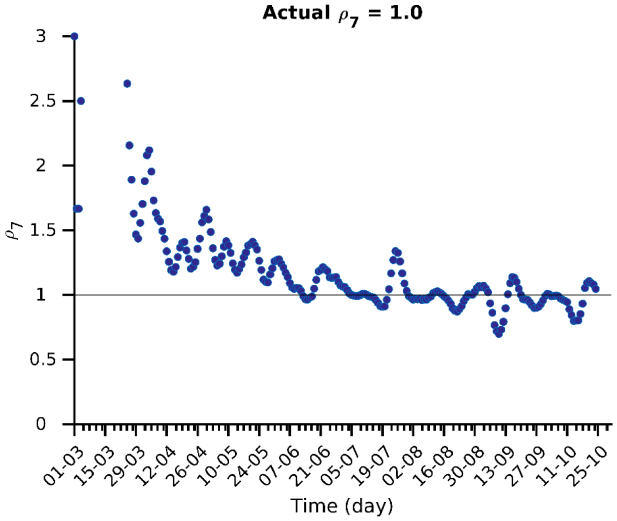
Day	Number of cases	95% Confidence Interval
26-10-2020	5417371 (+23243)	[5394128 - 5481425]
28-10-2020	5458522 (+20521)	[5394128 - 5524983]
30-10-2020	5499237 (+20303)	[5427721 - 5570754]

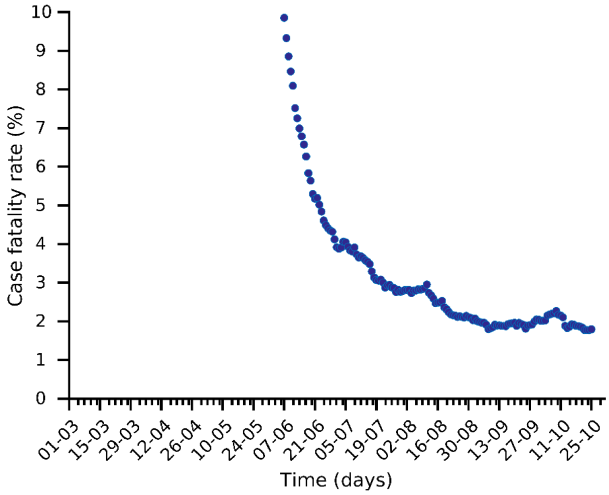
Current indicators

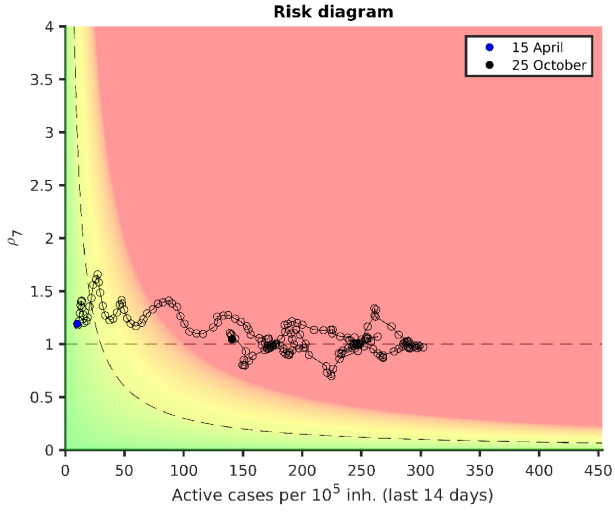
A_{14}	EPG	CFR
141	147	1.79 %

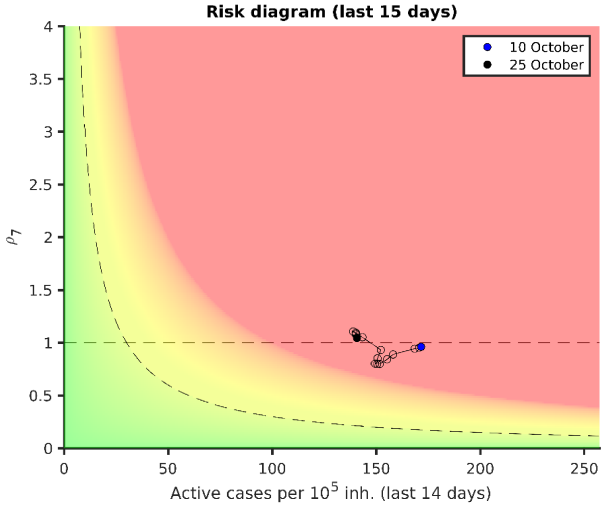




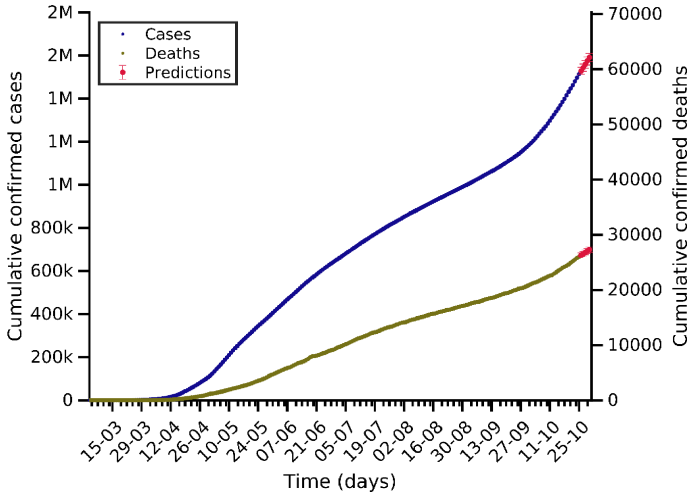








Russia 25-10-2020. Pop: 145.9M. Cumulative incidence: 1037/10⁵

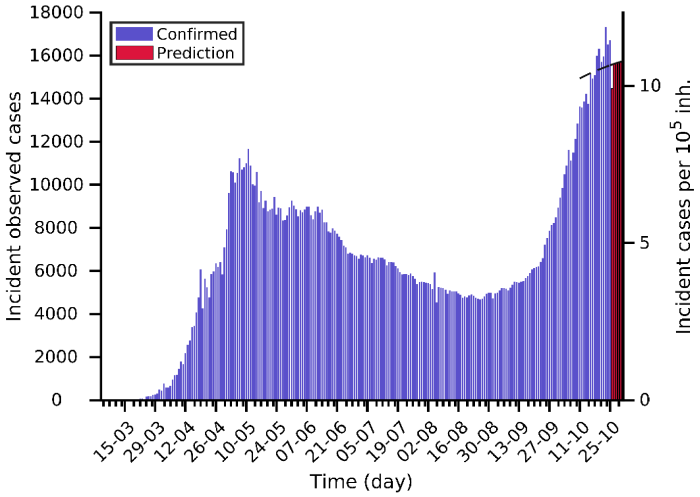


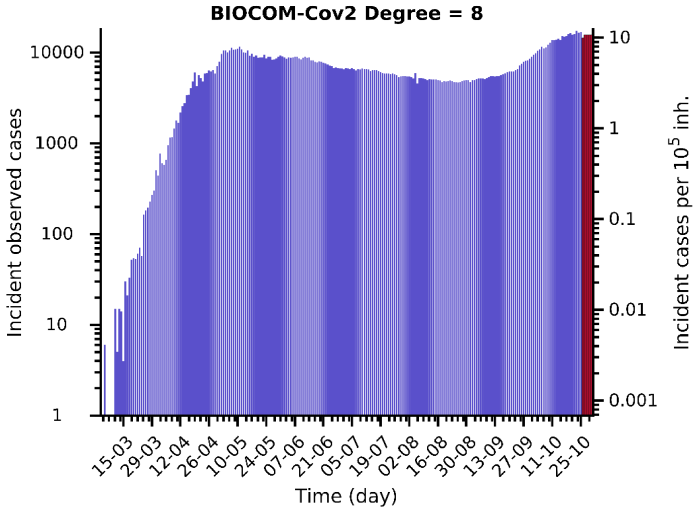
Predictions for next days

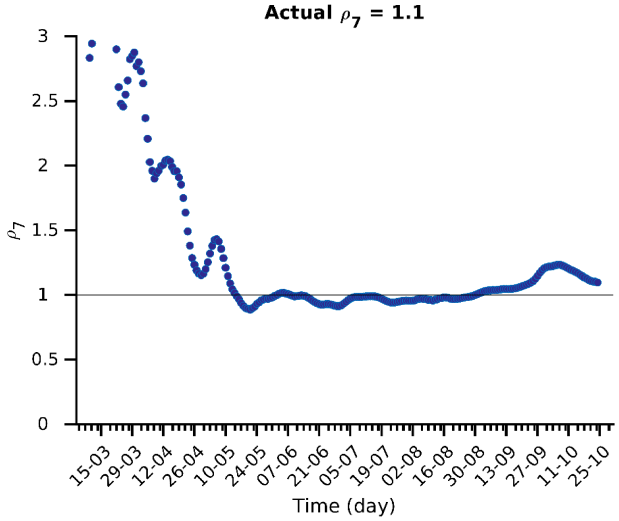
Day	Number of cases	95% Confidence Interval
26-10-2020	1528338 (+14461)	[1513877 - 1545506]
28-10-2020	1559611 (+15652)	[1541743 - 1577479]
30-10-2020	1591007 (+15713)	[1571621 - 1610394]

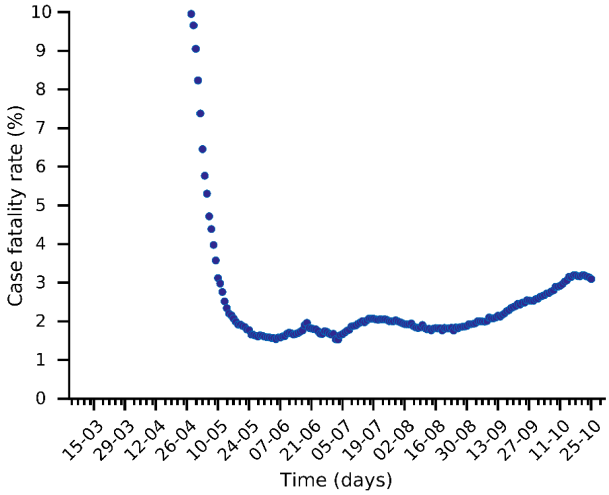
Current indicators

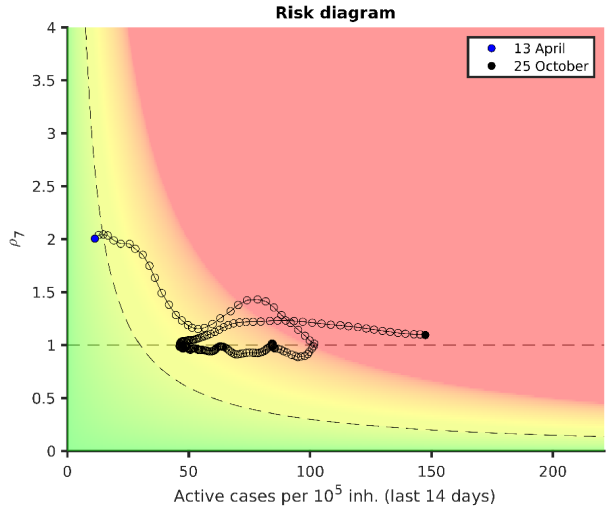
A_{14}	EPG	CFR
147	162	3.09 %

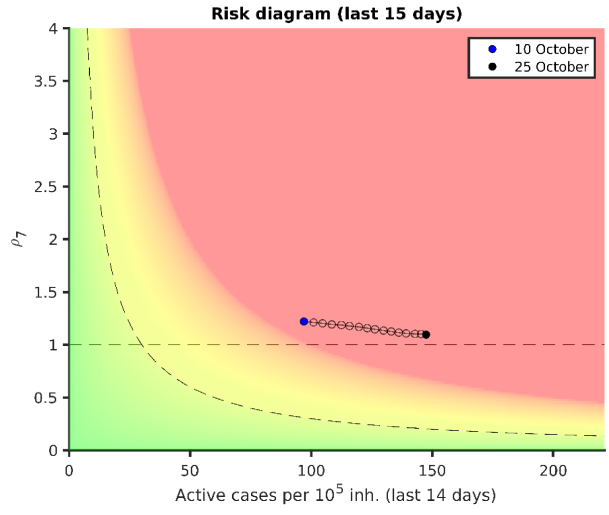




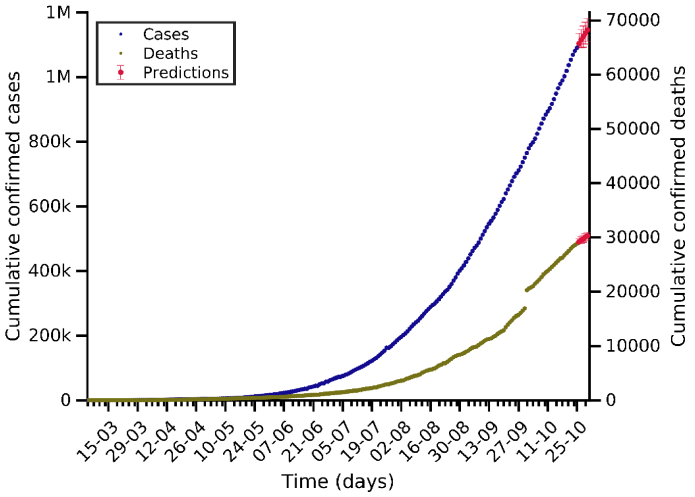








Argentina 25-10-2020. Pop: 45.2M. Cumulative incidence: 2413/10⁵

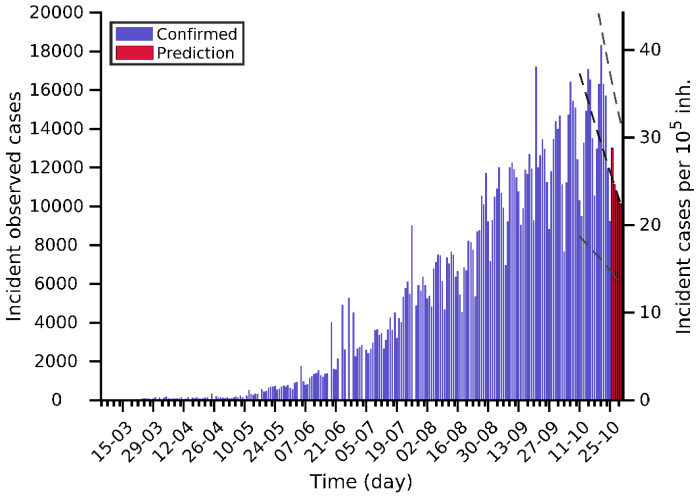


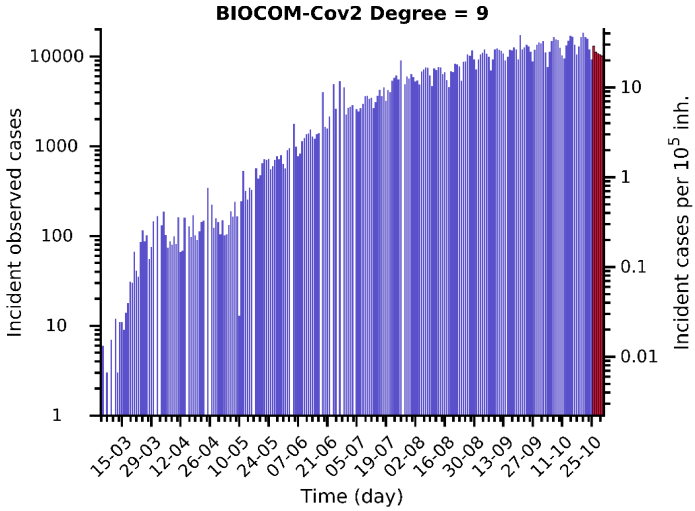
Predictions for next days

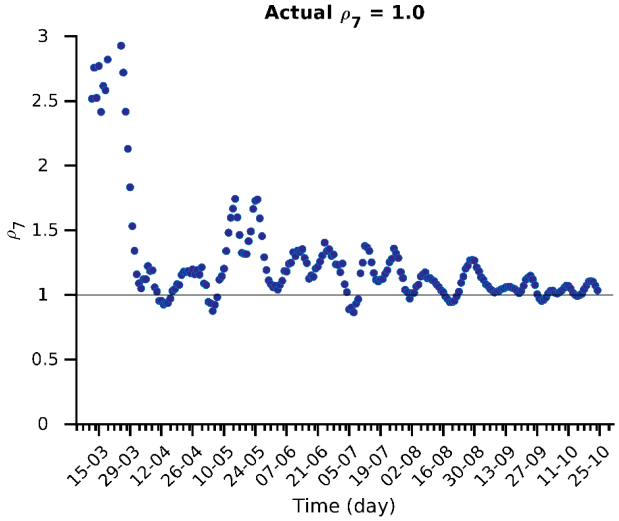
Day	Number of cases	95% Confidence Interval
26-10-2020	1103585 (+13009)	[1090576 - 1135519]
28-10-2020	1125499 (+10791)	[1092538 - 1158461]
30-10-2020	1146111 (+10146)	[1111135 - 1181088]

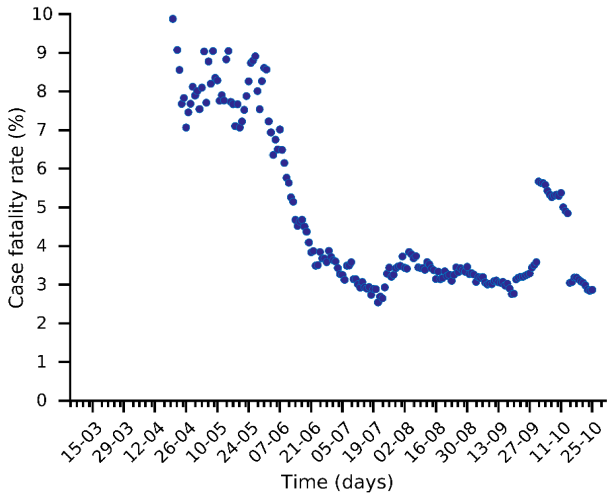
Current indicators

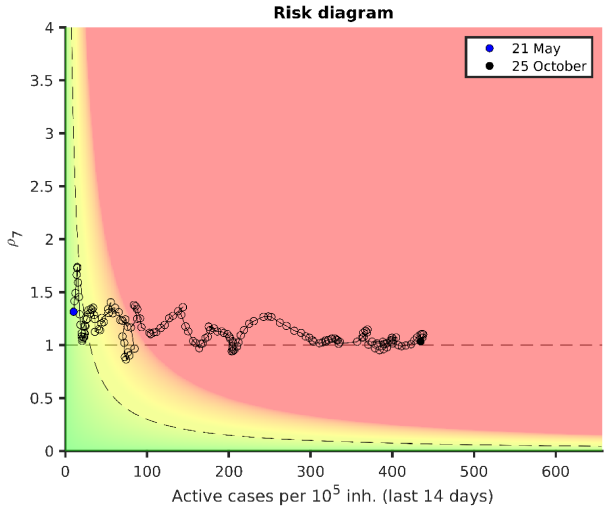
A_{14}	EPG	CFR
435	450	2.86 %

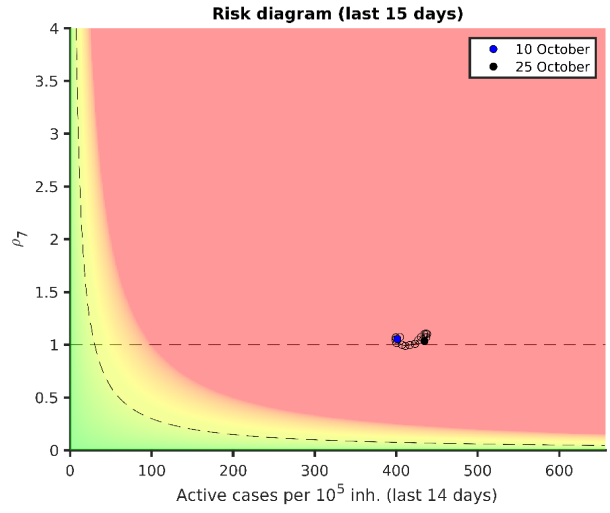




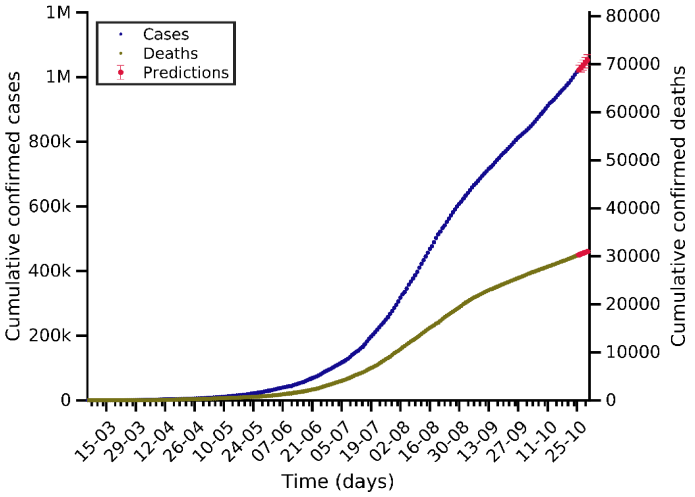








Colombia 25-10-2020. Pop: 50.9M. Cumulative incidence: 1997/10^5

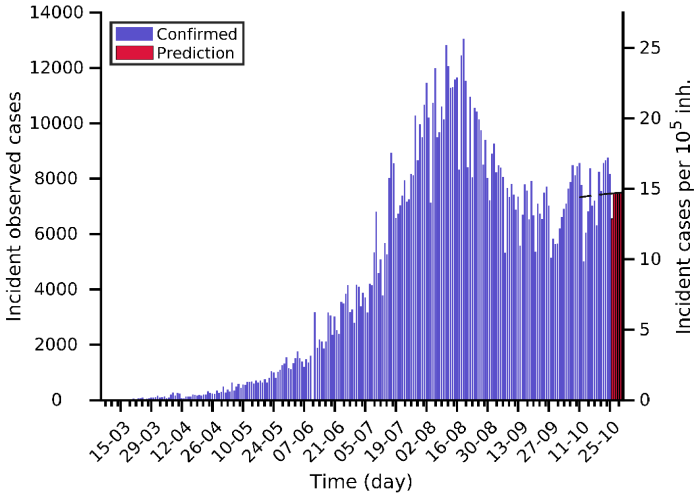


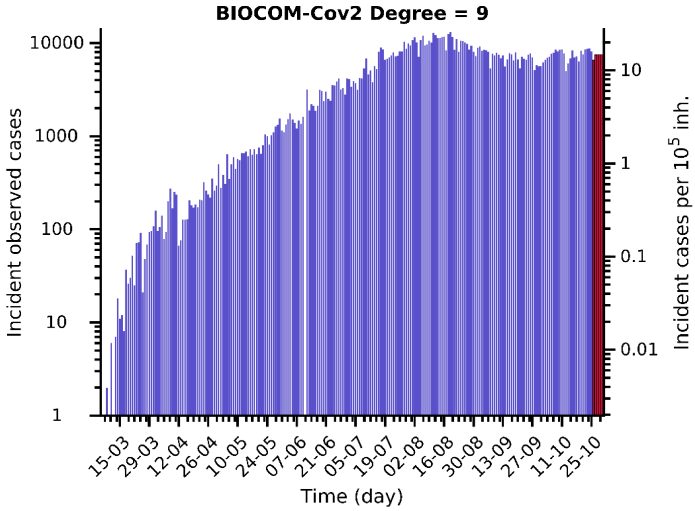
Predictions for next days

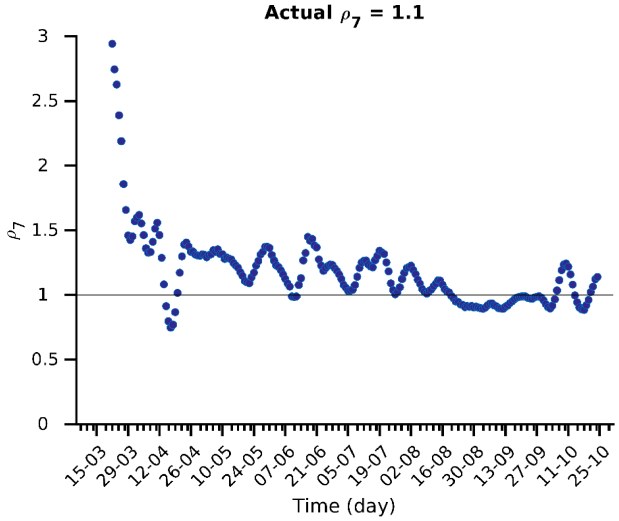
Day	Number of cases	95% Confidence Interval
26-10-2020	1022432 (+6547)	[1015885 - 1037512]
28-10-2020	1037389 (+7482)	[1021707 - 1053071]
30-10-2020	1052370 (+7493)	[1035392 - 1069348]

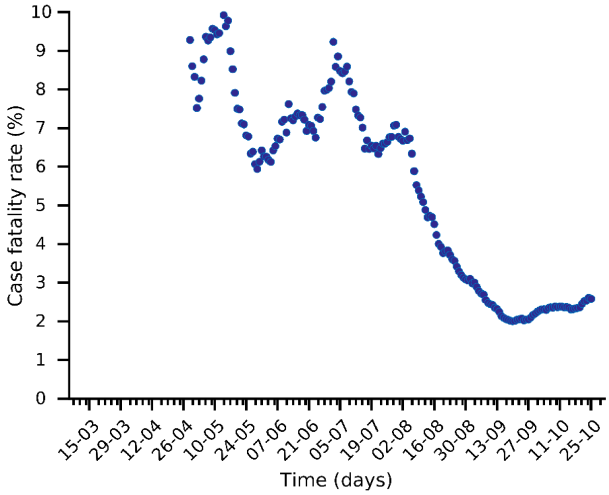
Current indicators

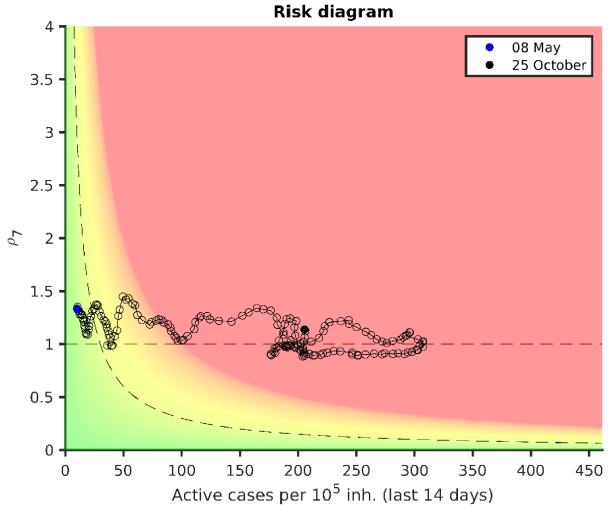
A_{14}	EPG	CFR
206	234	2.58 %

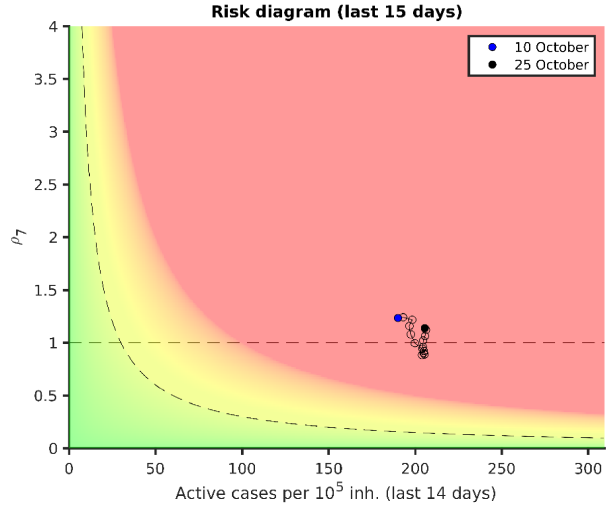




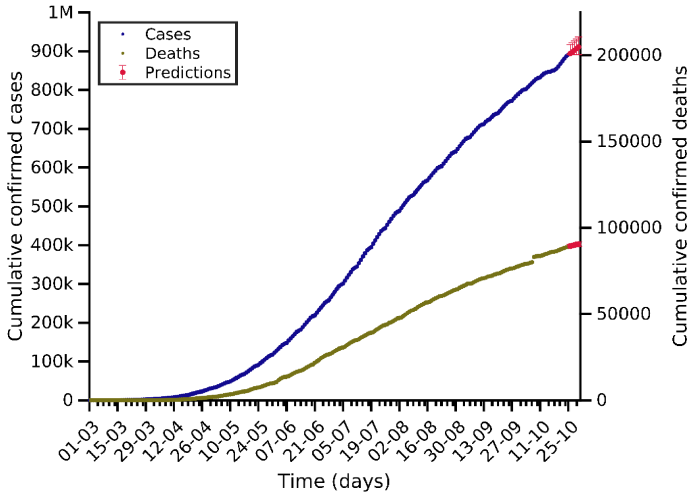








Mexico 25-10-2020. Pop: 128.9M. Cumulative incidence: 691/10^5

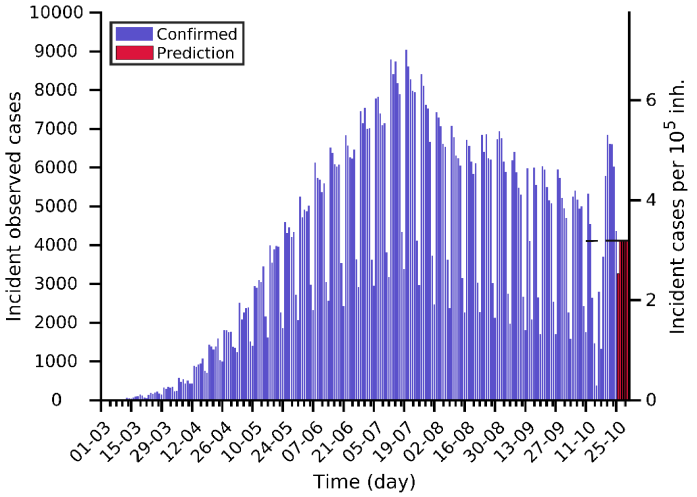


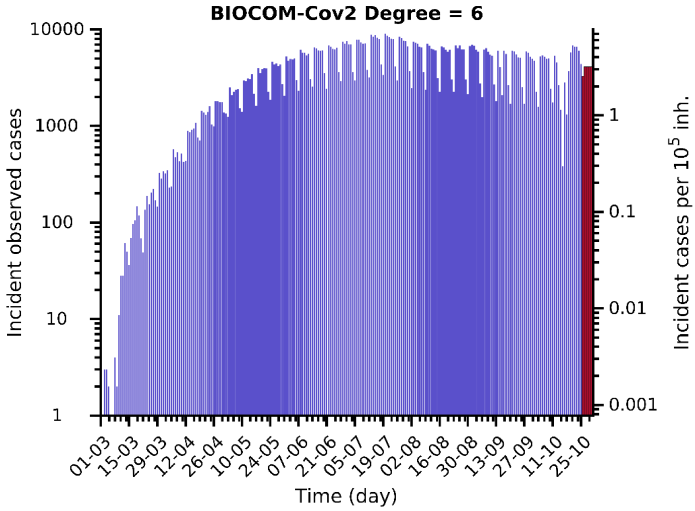
Predictions for next days

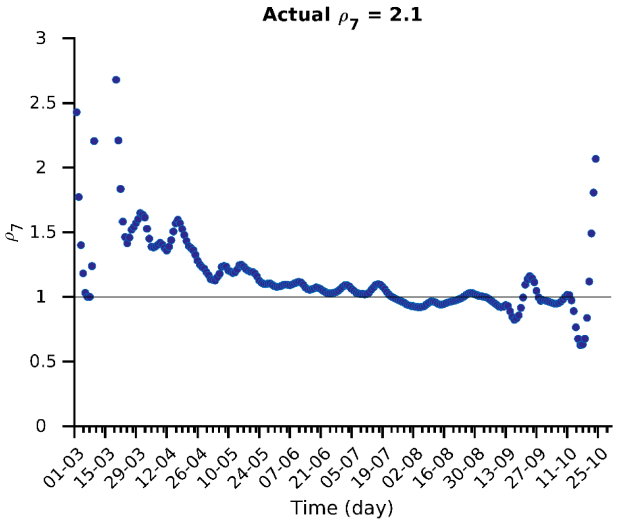
Day	Number of cases	95% Confidence Interval
26-10-2020	894423 (+3263)	[891160 - 917368]
28-10-2020	902660 (+4119)	[891160 - 926506]
30-10-2020	910898 (+4119)	[891160 - 936670]

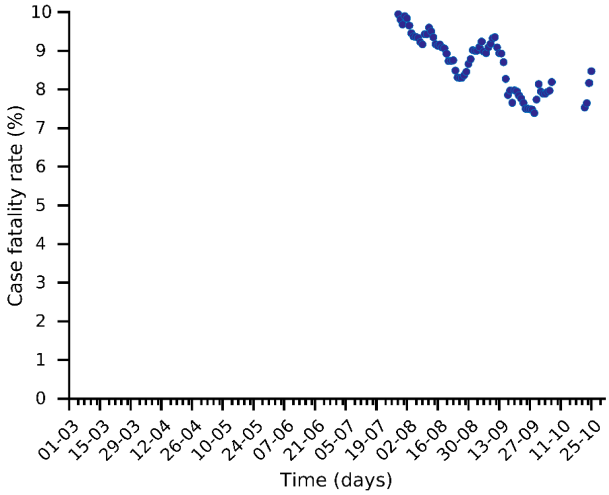
Current indicators

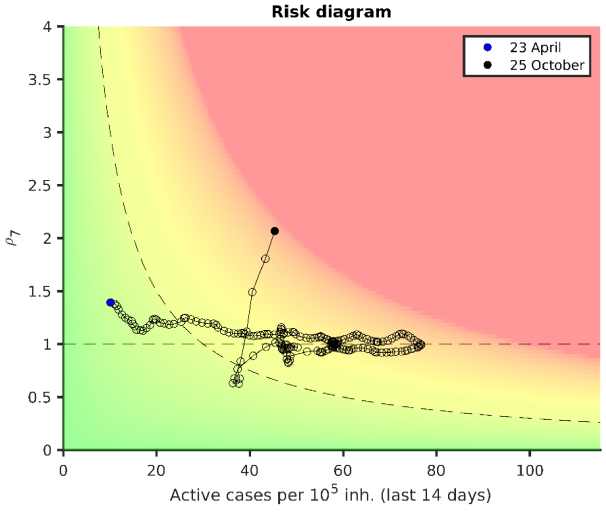
A_{14}	EPG	CFR
45	94	8.47 %

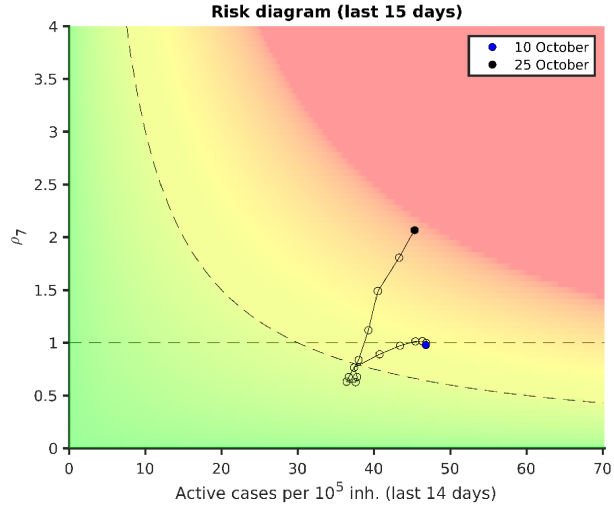




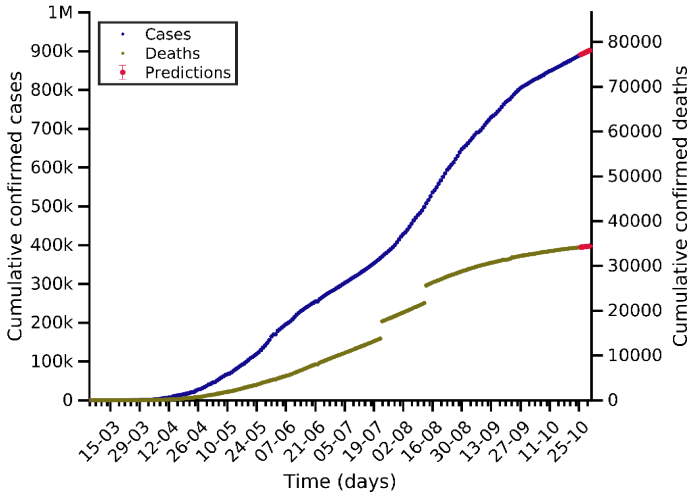








Peru 25-10-2020. Pop: 33.0M. Cumulative incidence: 2695/10⁵

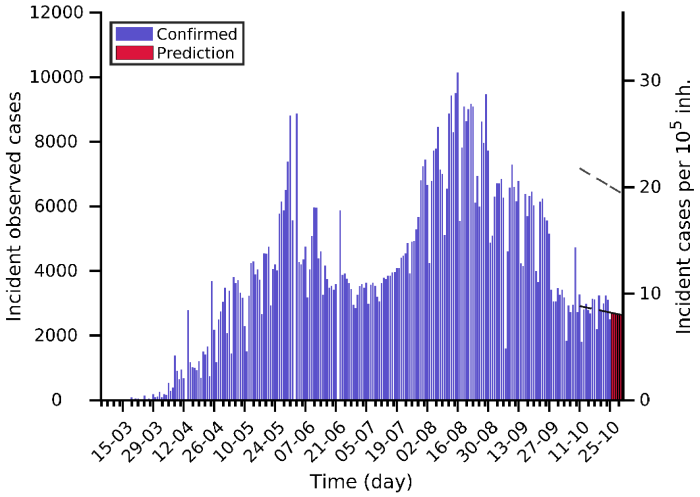


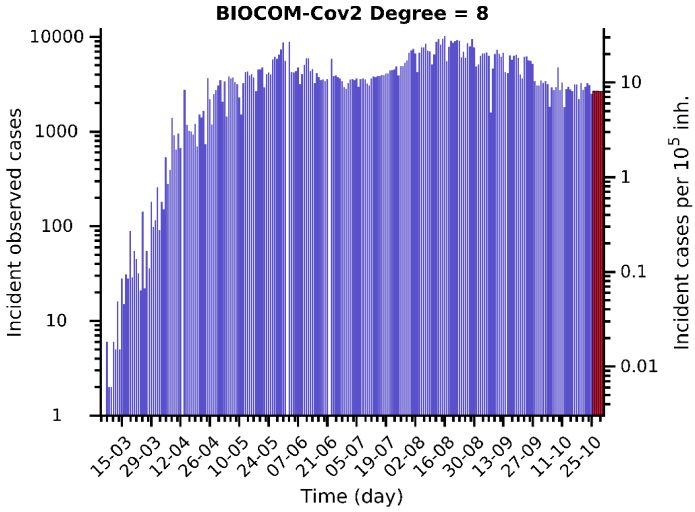
Predictions for next days

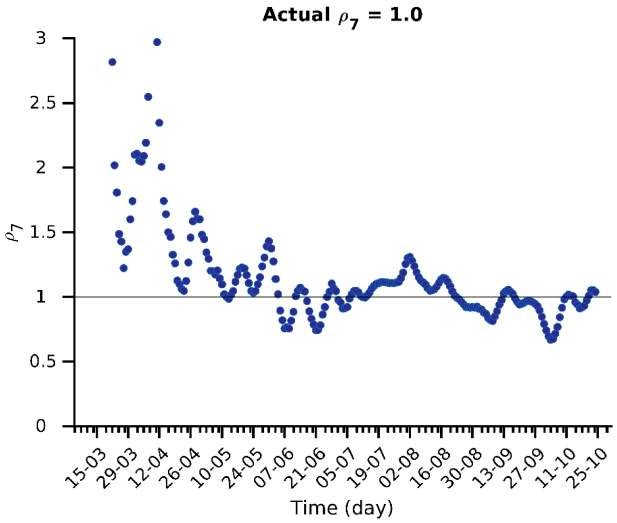
Day	Number of cases	95% Confidence Interval
26-10-2020	891388 (+2673)	[888715 - 895115]
28-10-2020	896747 (+2672)	[892881 - 900613]
30-10-2020	902048 (+2644)	[897890 - 906207]

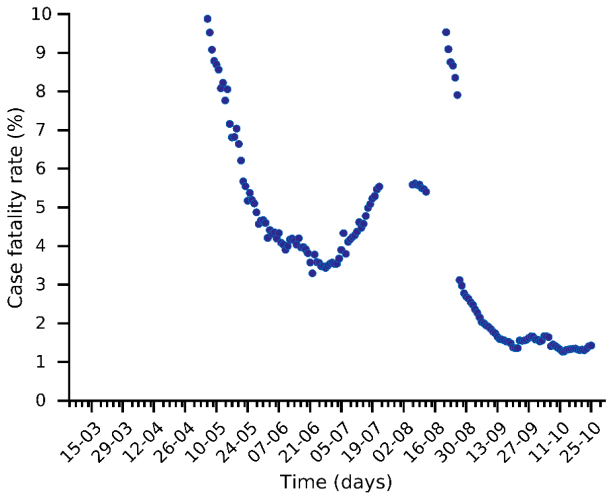
Current indicators

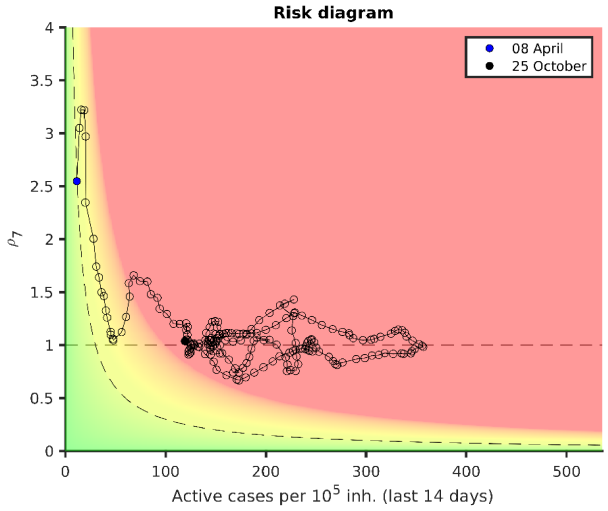
A_{14}	EPG	CFR
119	124	1.42 %

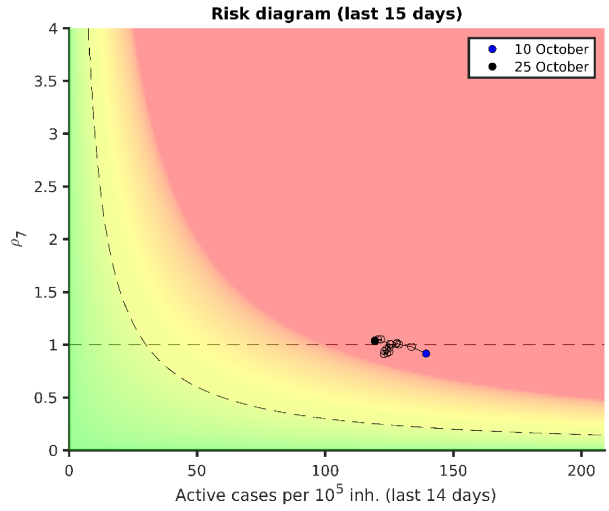




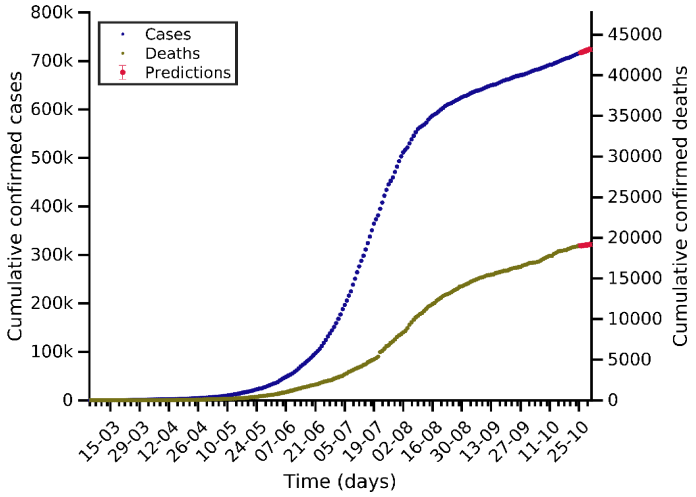








South Africa 25-10-2020. Pop: 59.3M. Cumulative incidence: 1207/10^5

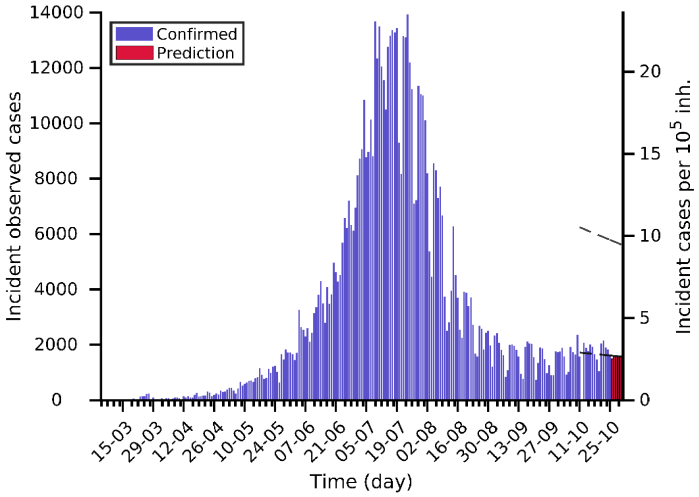


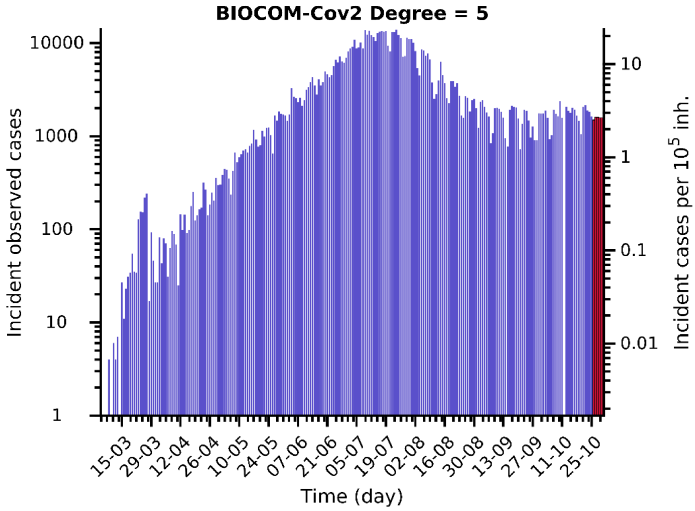
Predictions for next days

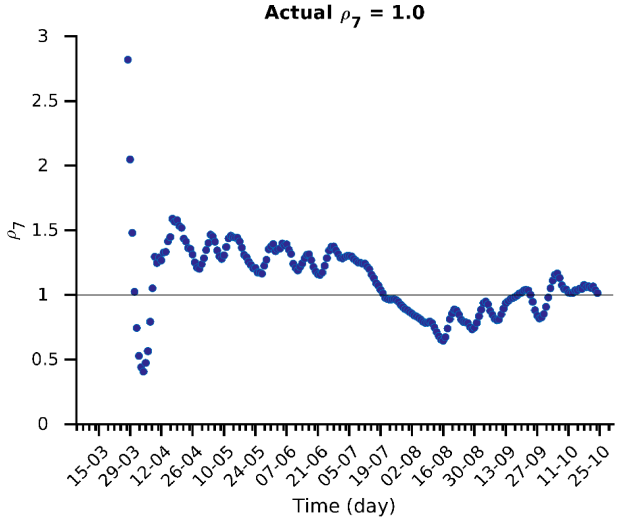
Day	Number of cases	95% Confidence Interval
26-10-2020	717363 (+1495)	[715868 - 720639]
28-10-2020	720555 (+1592)	[717156 - 723953]
30-10-2020	723716 (+1577)	[720059 - 727373]

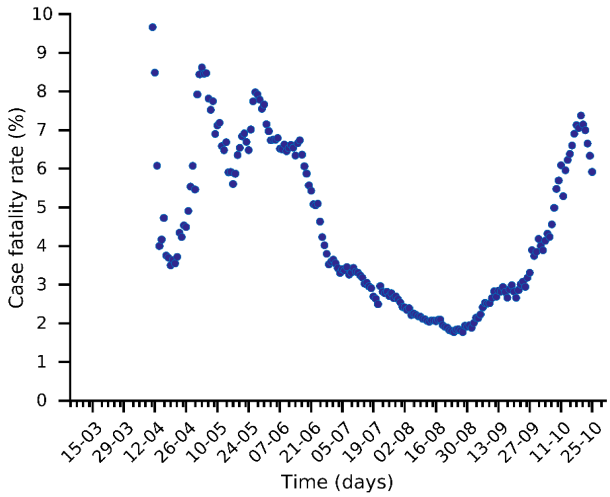
Current indicators

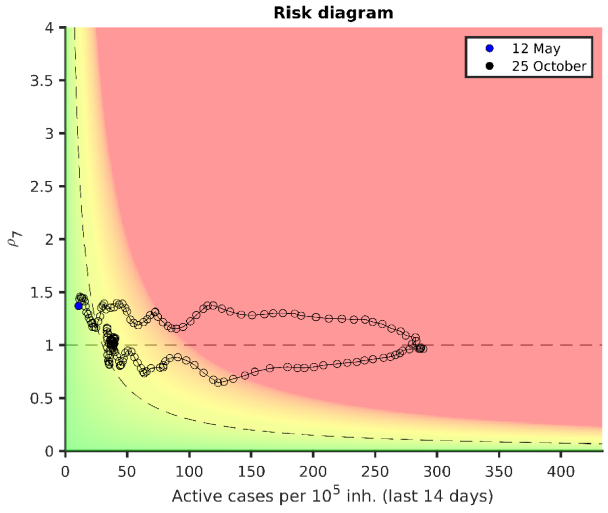
A_{14}	EPG	CFR
39	40	5.92 %

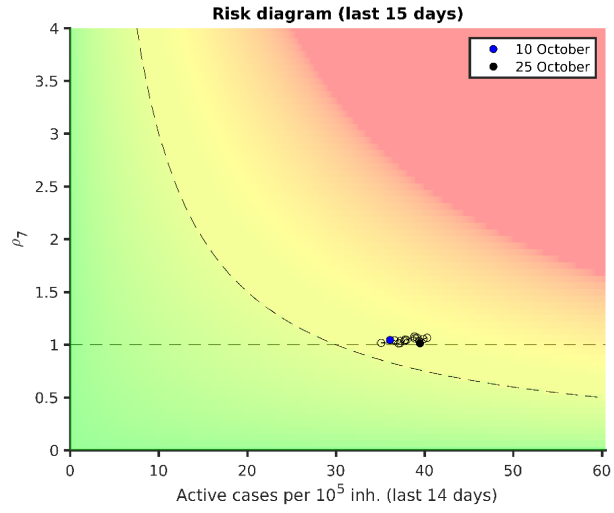




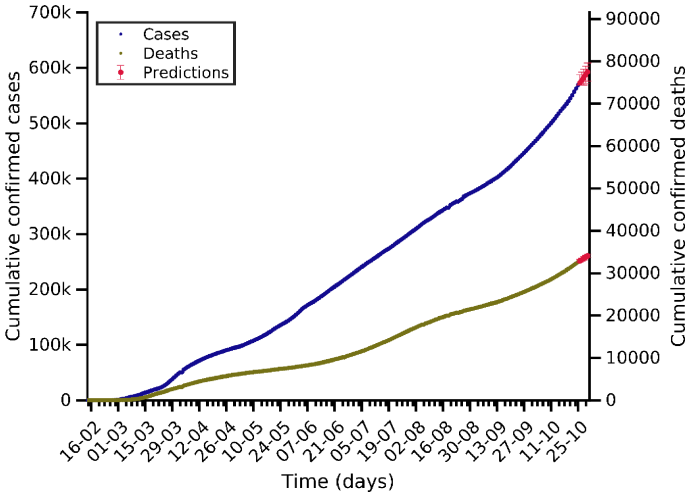








Iran 25-10-2020. Pop: 84.0M. Cumulative incidence: 677/10^5

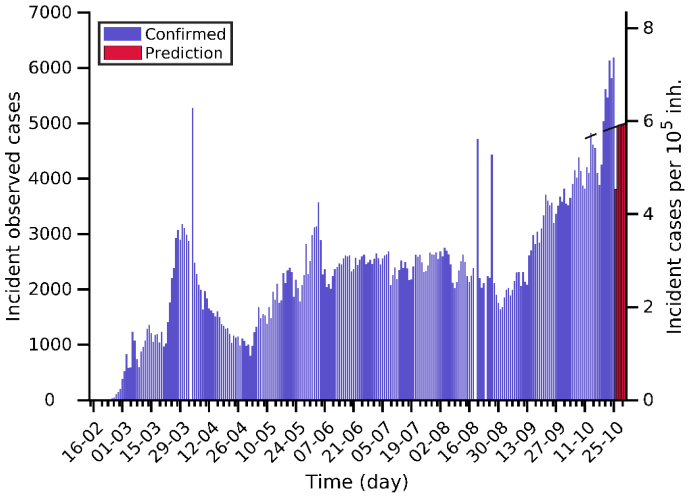


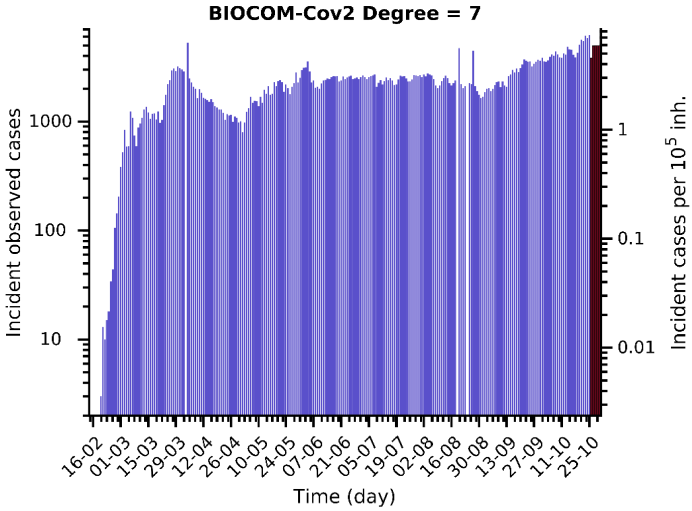
Predictions for next days

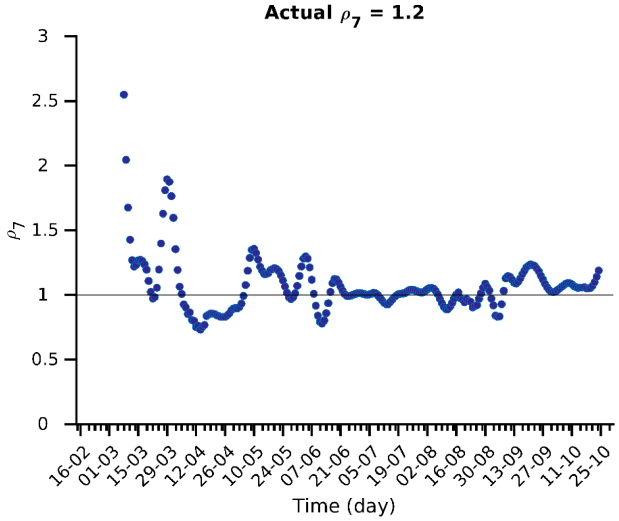
Day	Number of cases	95% Confidence Interval
26-10-2020	572704 (+3808)	[568896 - 587324]
28-10-2020	582621 (+4965)	[568896 - 597835]
30-10-2020	592587 (+4989)	[576086 - 609089]

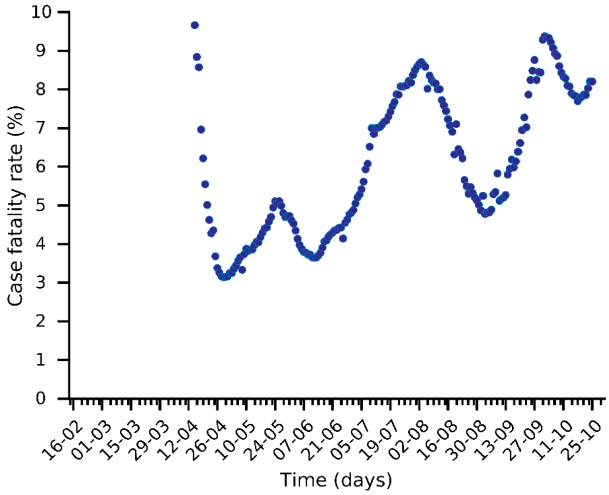
Current indicators

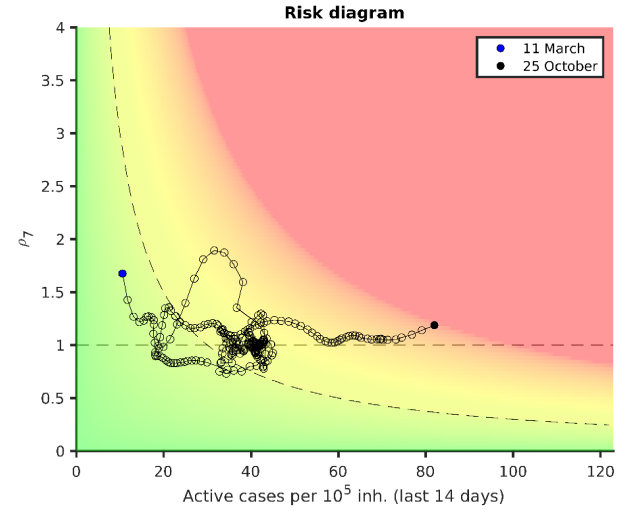
A_{14}	EPG	CFR
82	97	8.20 %

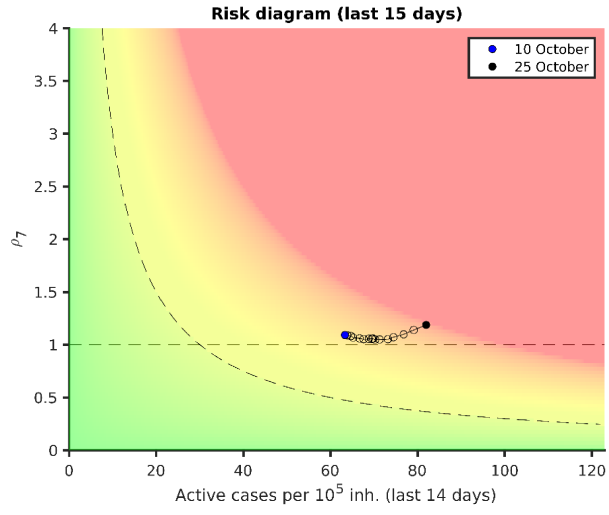




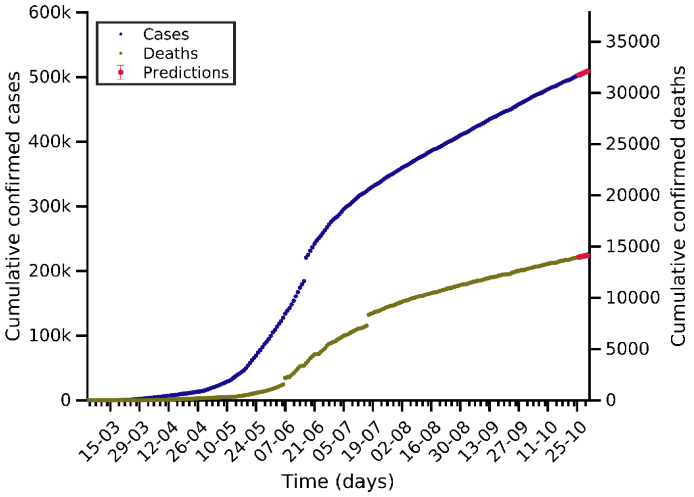








Chile 25-10-2020. Pop: 19.1M. Cumulative incidence: 2626/10^5

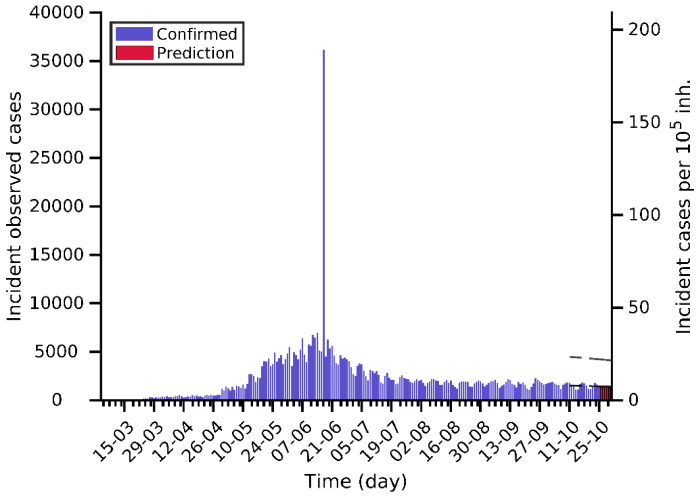


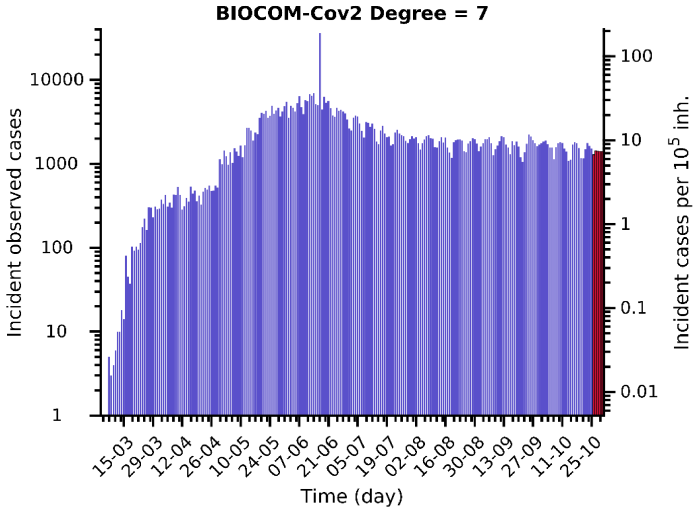
Predictions for next days

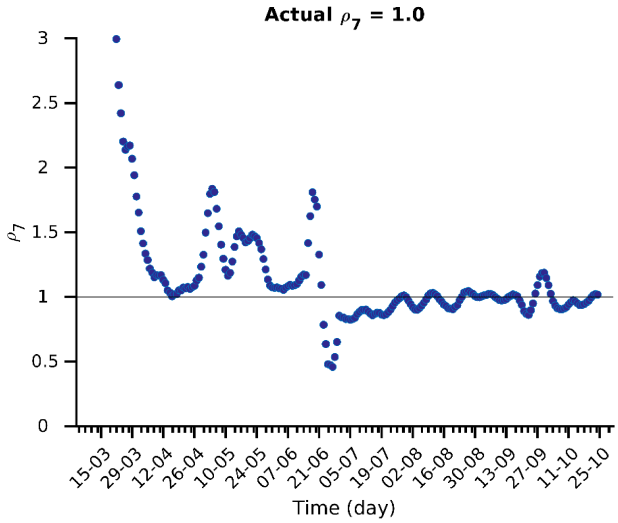
Day	Number of cases	95% Confidence Interval
26-10-2020	503348 (+1285)	[502063 - 505510]
28-10-2020	506180 (+1413)	[503936 - 508424]
30-10-2020	508989 (+1402)	[506573 - 511405]

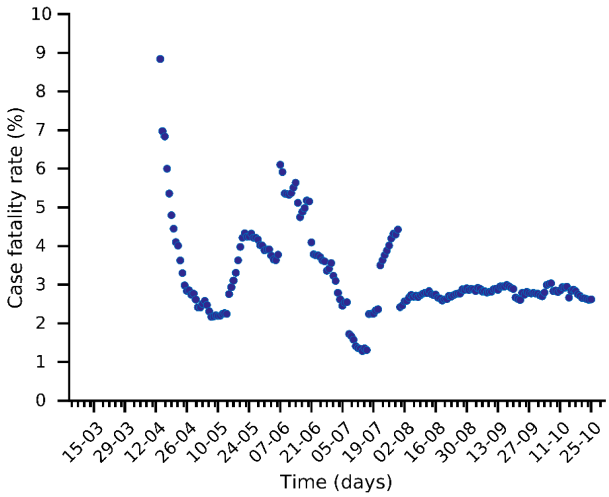
Current indicators

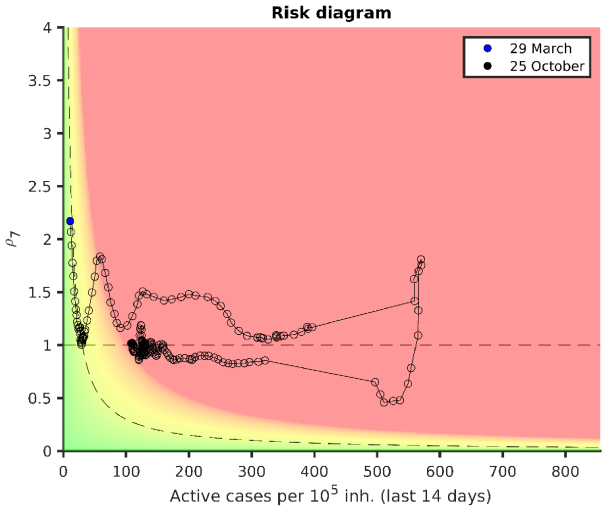
A_{14}	EPG	CFR
108	110	2.62 %

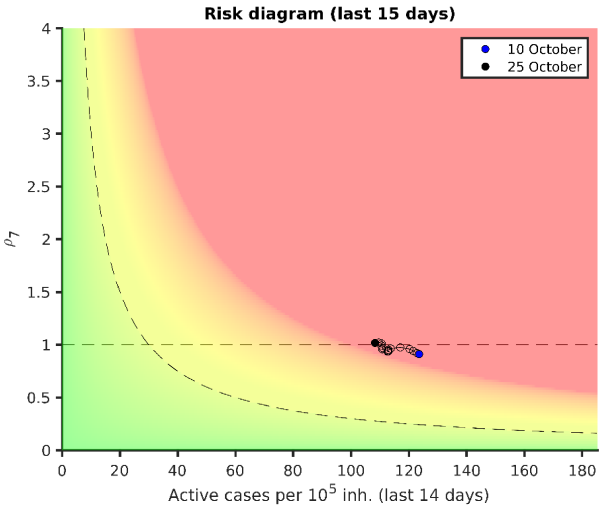




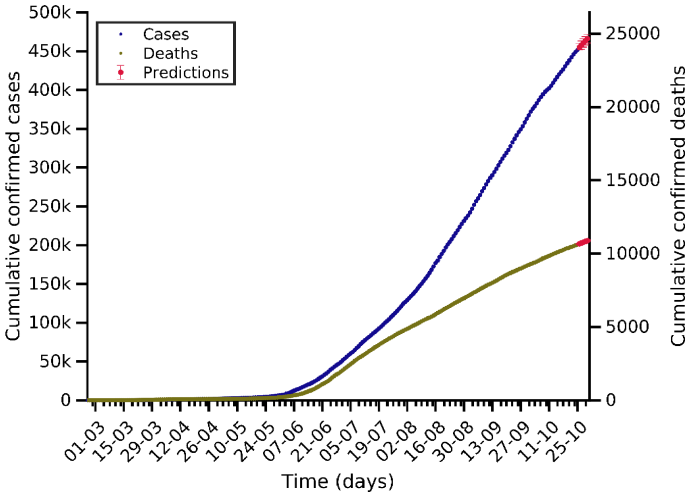








Iraq 25-10-2020. Pop: 40.2M. Cumulative incidence: 1123/10^5

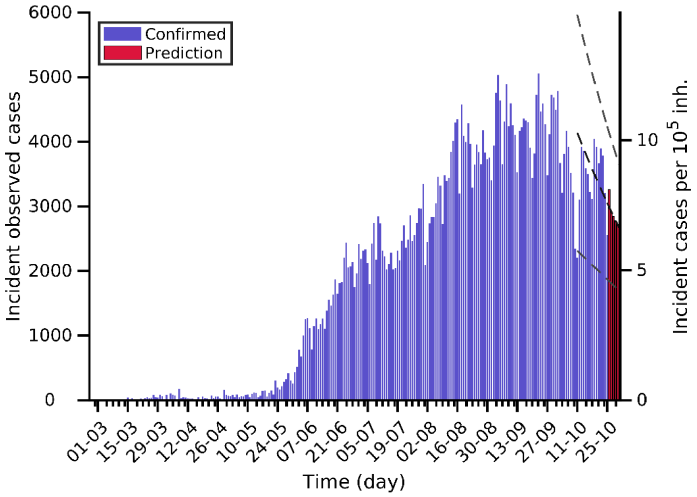


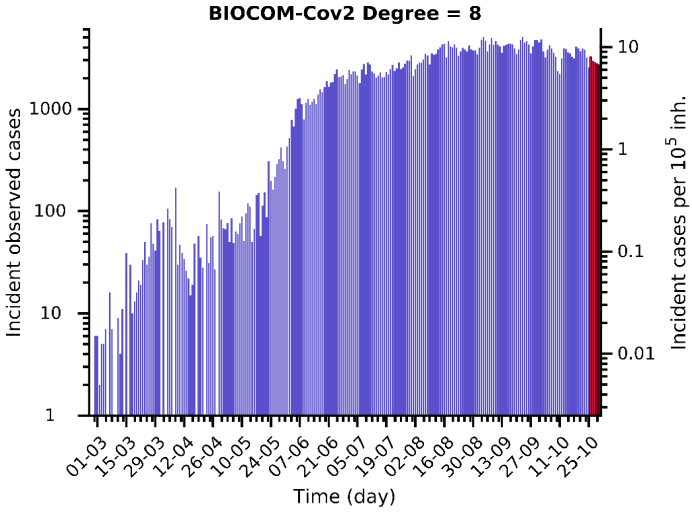
Predictions for next days

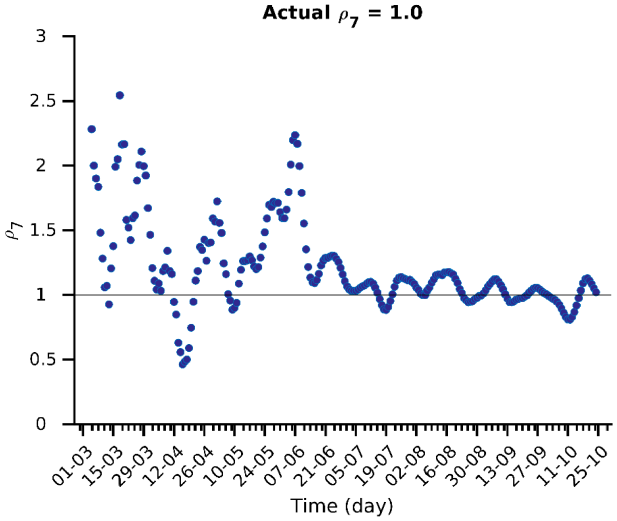
Day	Number of cases	95% Confidence Interval
26-10-2020	454968 (+3261)	[451707 - 460187]
28-10-2020	460731 (+2847)	[455340 - 466122]
30-10-2020	466224 (+2713)	[460489 - 471958]

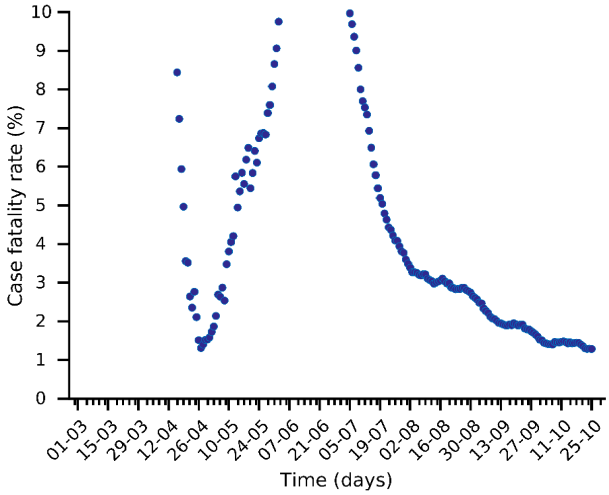
Current indicators

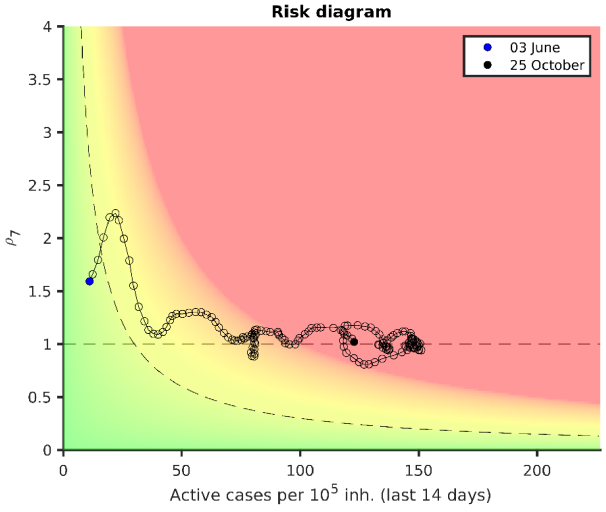
A_{14}	EPG	CFR
123	125	1.28 %

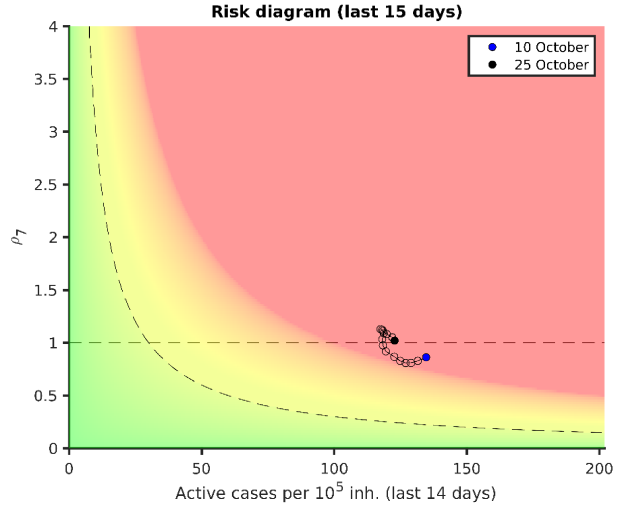




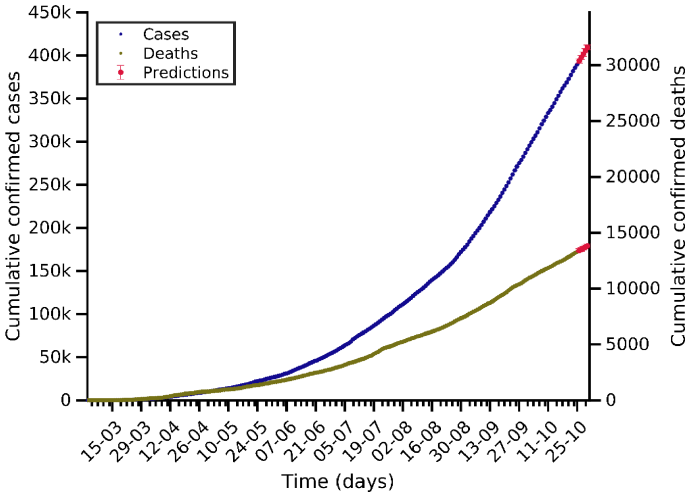








Indonesia 25-10-2020. Pop: 273.5M. Cumulative incidence: 142/10⁵

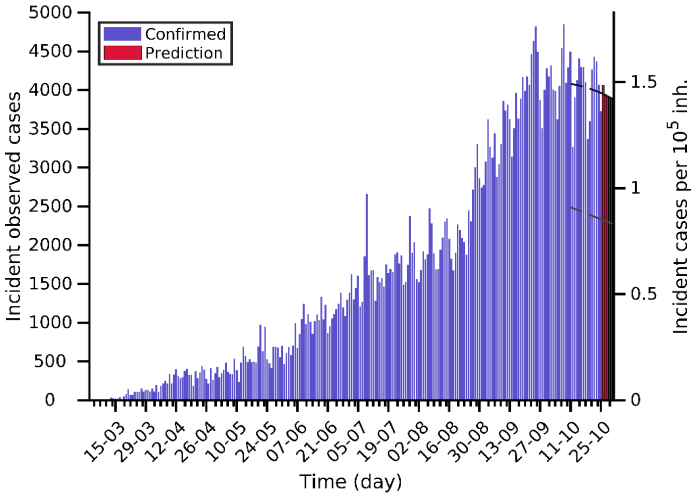


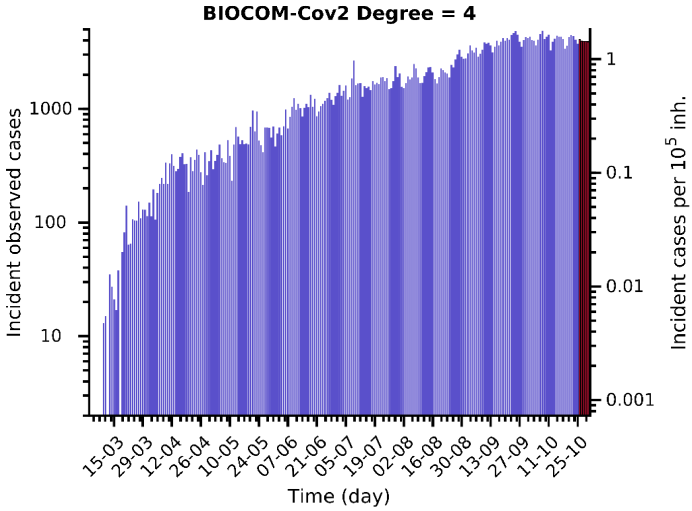
Predictions for next days

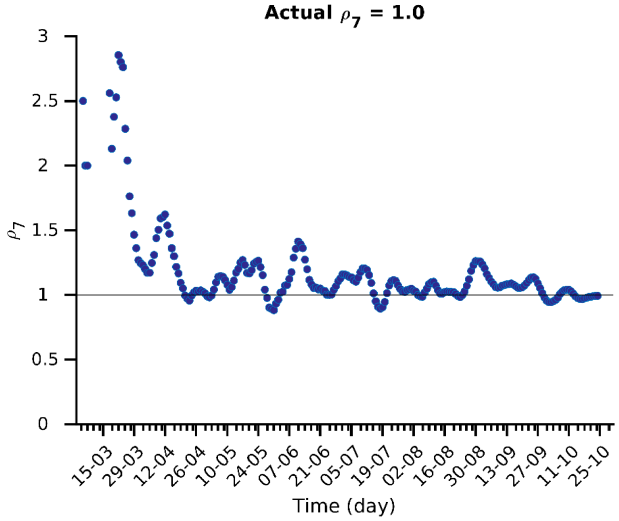
Day	Number of cases	95% Confidence Interval
26-10-2020	393772 (+4060)	[391406 - 396137]
28-10-2020	401632 (+3924)	[399174 - 404090]
30-10-2020	409437 (+3895)	[406782 - 412093]

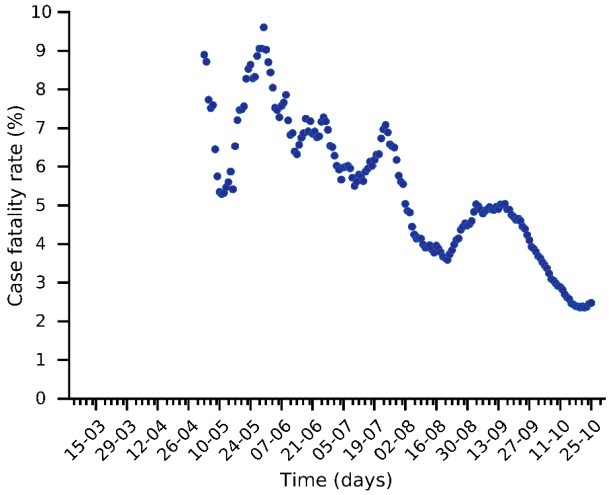
Current indicators

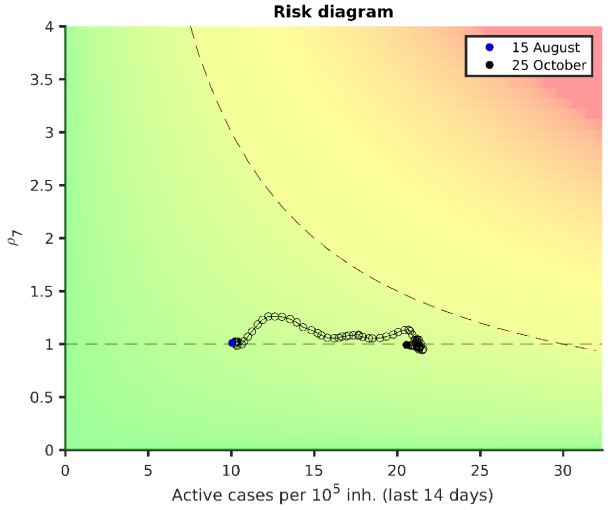
A_{14}	EPG	CFR
21	20	2.47 %

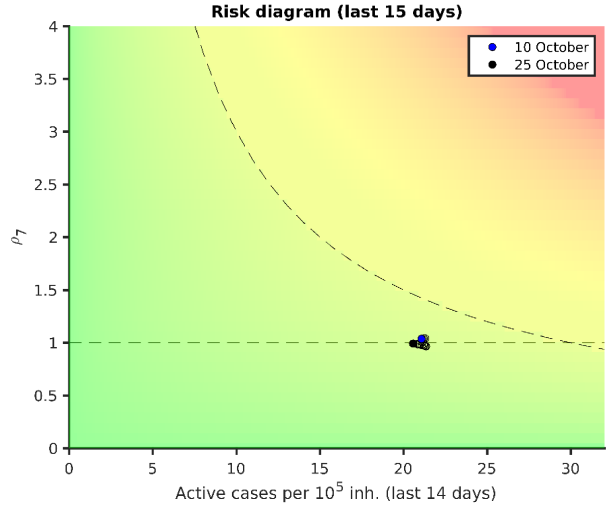




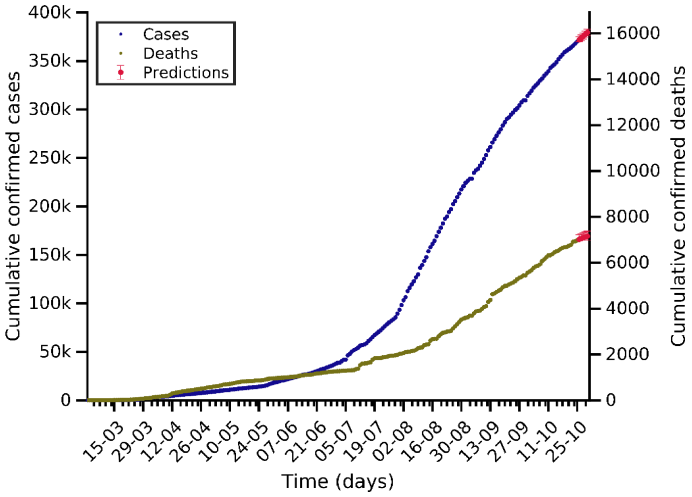








Philippines 25-10-2020. Pop: 109.6M. Cumulative incidence: 338/10⁵

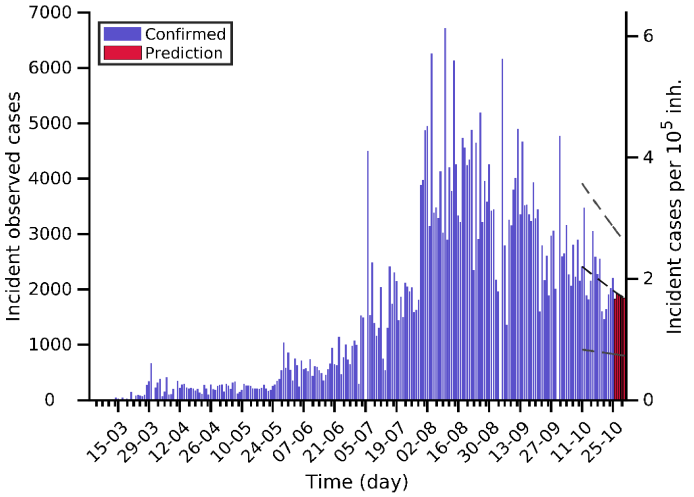


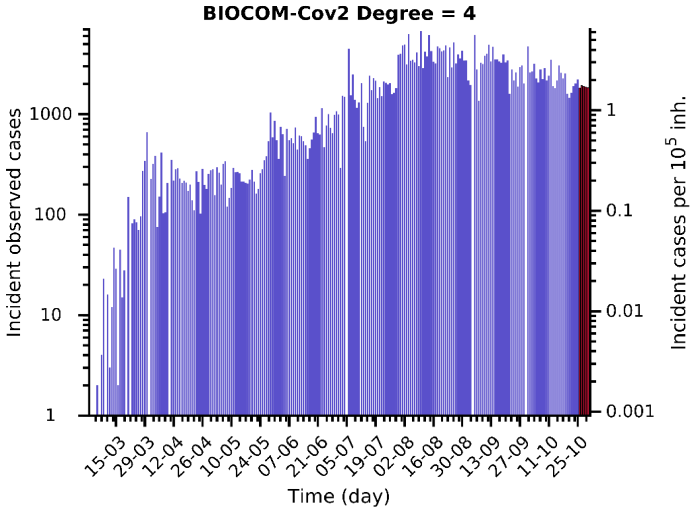
Predictions for next days

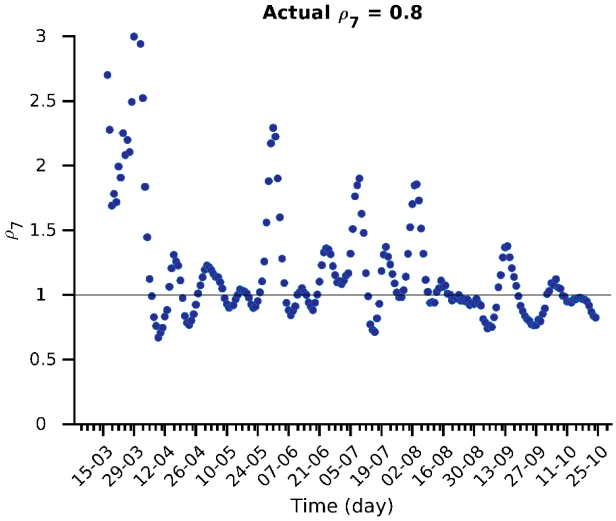
Day	Number of cases	95% Confidence Interval
26-10-2020	371853 (+1825)	[370028 - 374874]
28-10-2020	375679 (+1899)	[372552 - 378806]
30-10-2020	379390 (+1842)	[376047 - 382734]

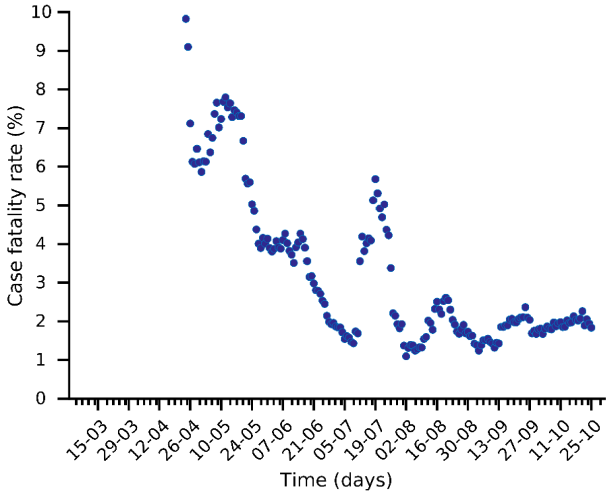
Current indicators

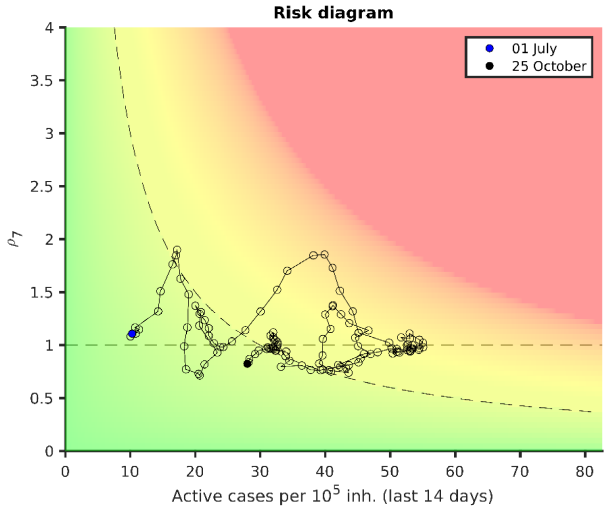
A_{14}	EPG	CFR
28	23	1.83 %

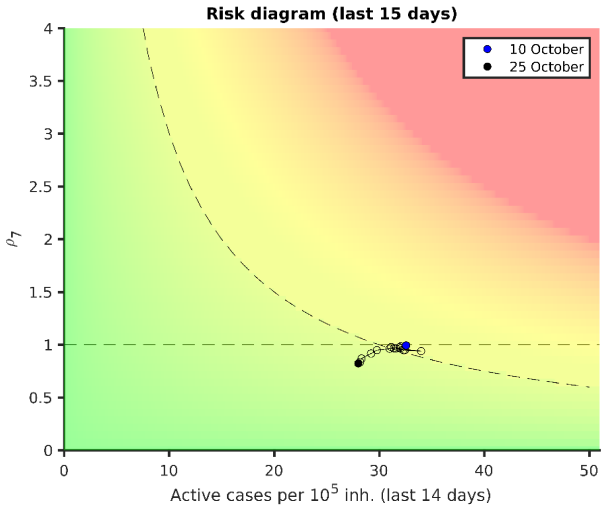




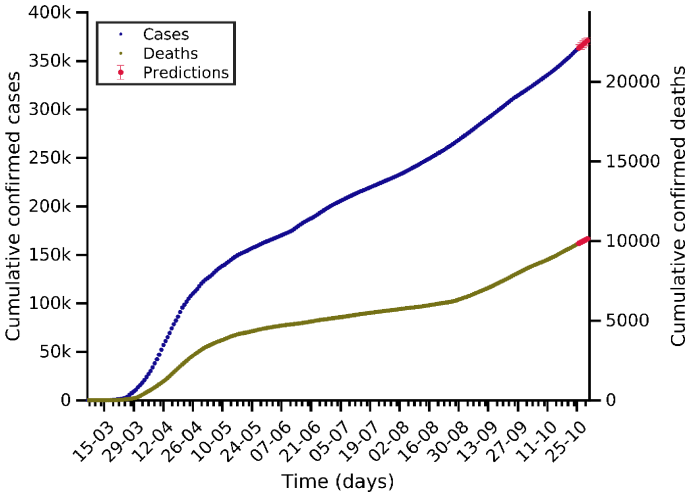








Turkey 25-10-2020. Pop: 84.3M. Cumulative incidence: 429/10⁵

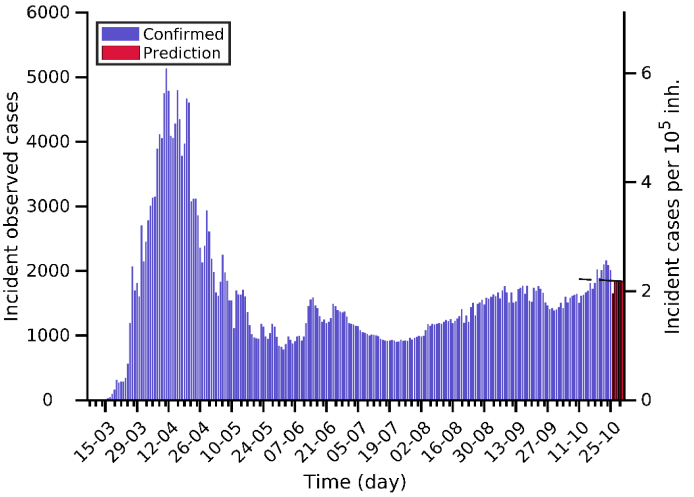


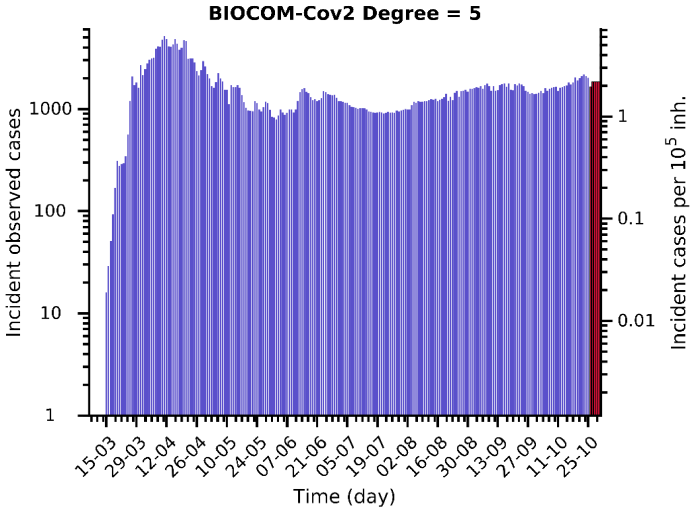
Predictions for next days

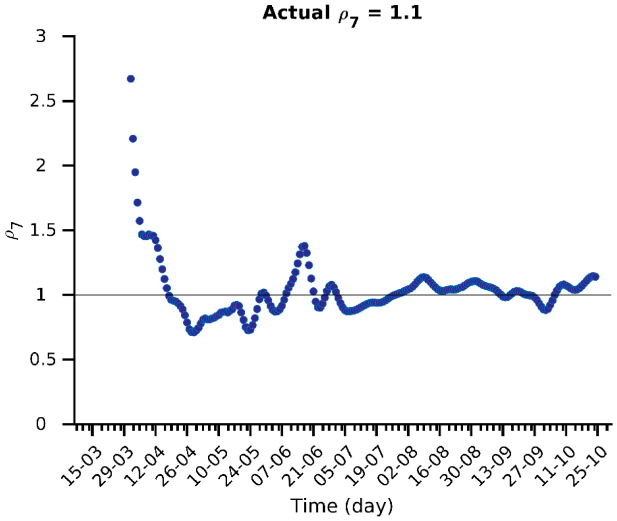
Day	Number of cases	95% Confidence Interval
26-10-2020	363452 (+1651)	[361801 - 366798]
28-10-2020	367142 (+1844)	[363665 - 370619]
30-10-2020	370824 (+1840)	[367069 - 374579]

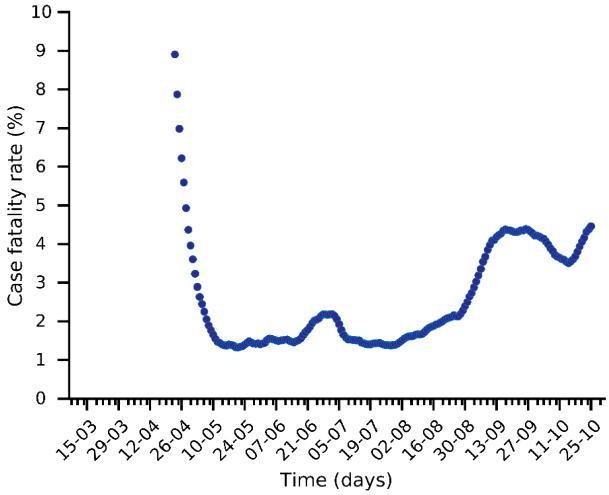
Current indicators

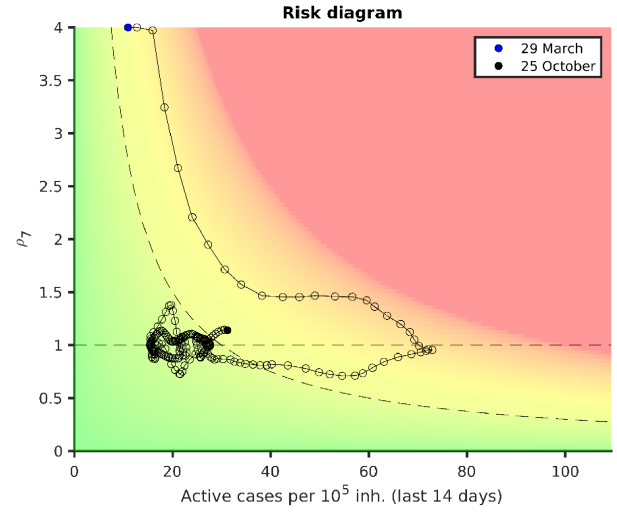
A_{14}	EPG	CFR
31	36	4.46 %

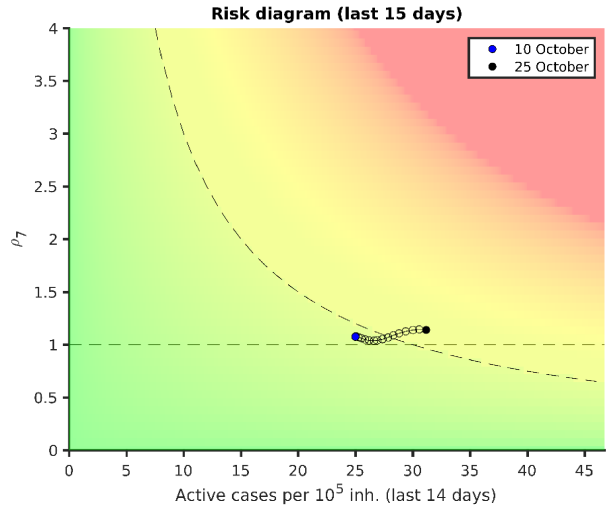




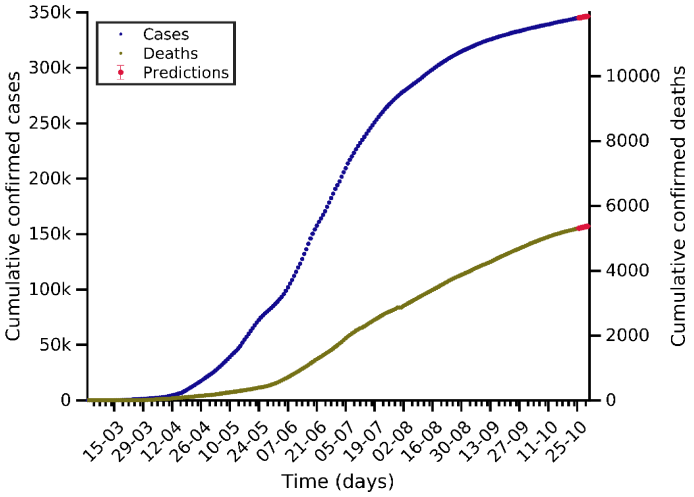








Saudi Arabia 25-10-2020. Pop: 34.8M. Cumulative incidence: 991/10^5

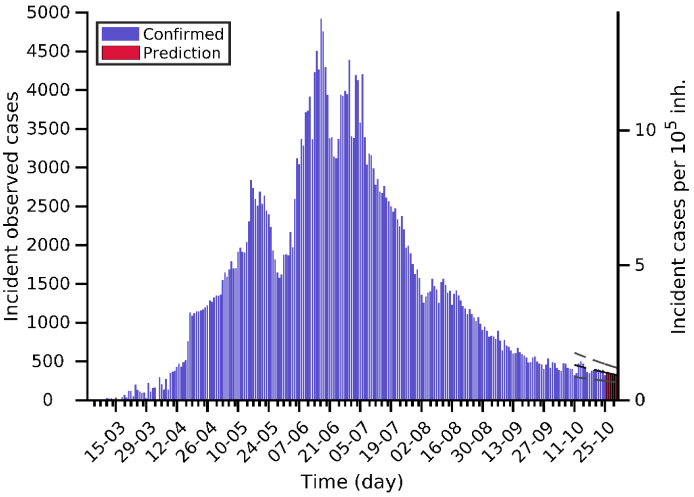


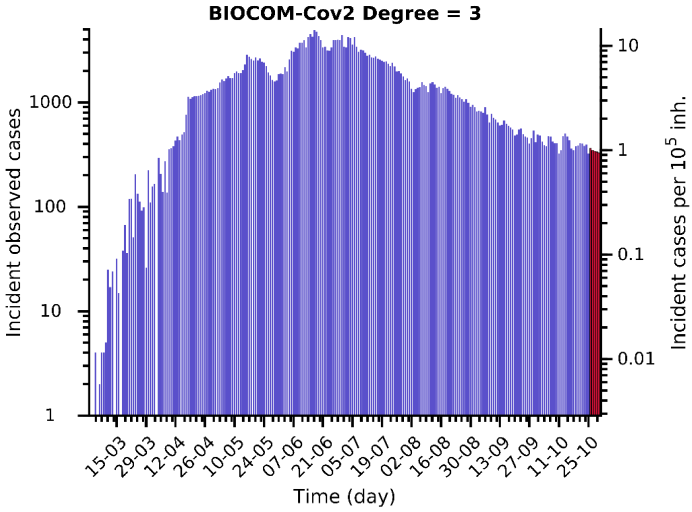
Predictions for next days

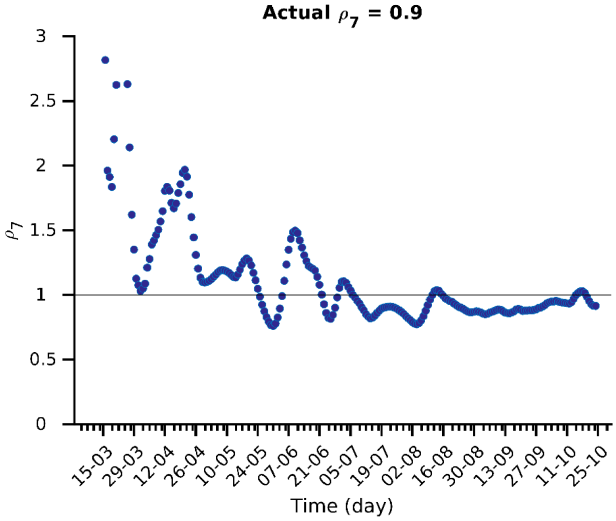
Day	Number of cases	95% Confidence Interval
26-10-2020	345239 (+364)	[344964 - 345514]
28-10-2020	345924 (+340)	[345639 - 346209]
30-10-2020	346585 (+328)	[346282 - 346889]

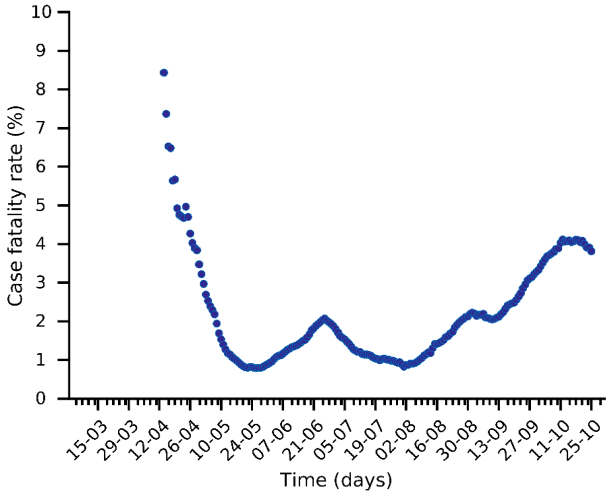
Current indicators

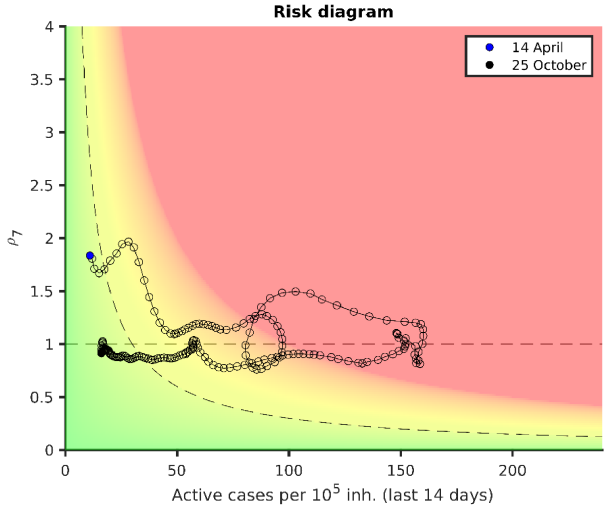
A_{14}	EPG	CFR
16	15	3.81 %

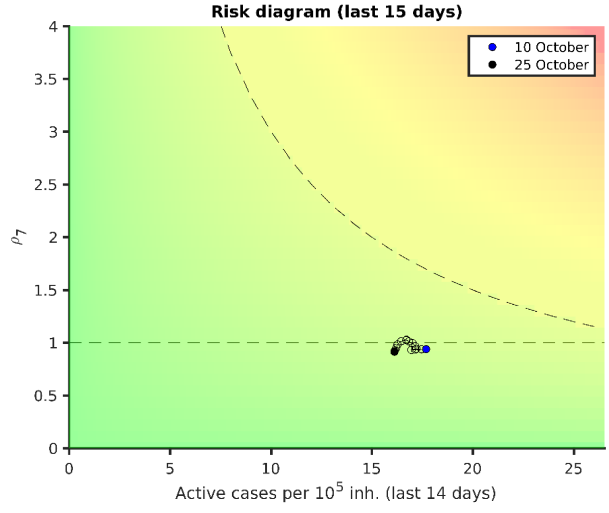




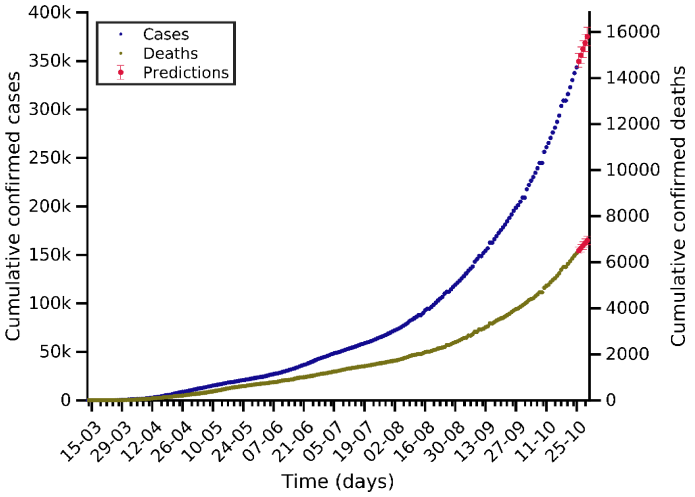








Ukraine 25-10-2020. Pop: 43.7M. Cumulative incidence: 785/10^5

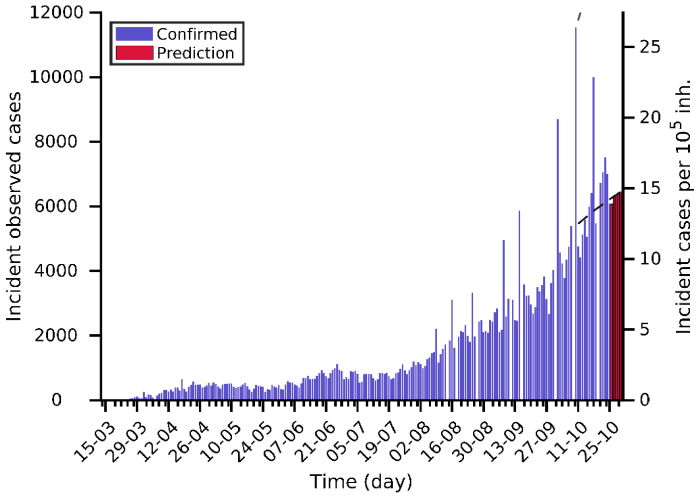


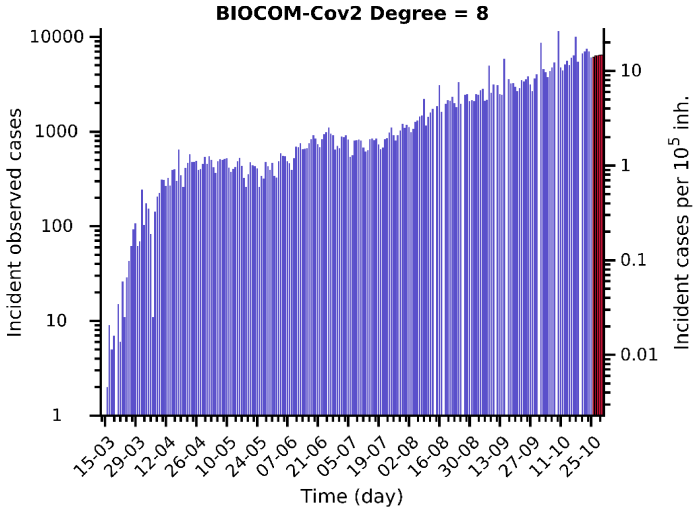
Predictions for next days

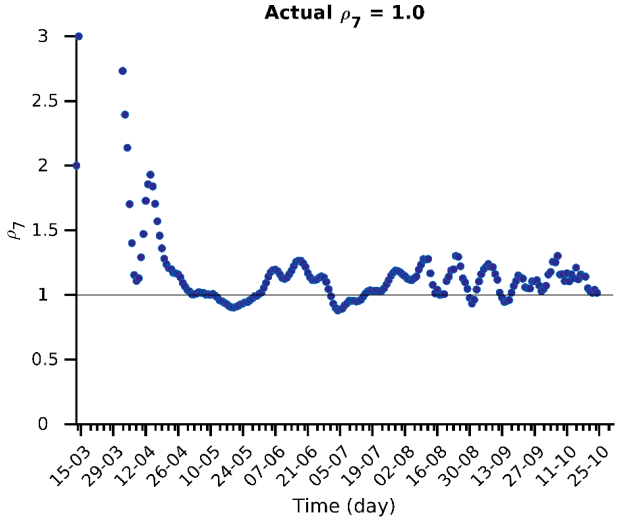
Day	Number of cases	95% Confidence Interval
26-10-2020	349560 (+6071)	[343489 - 357869]
28-10-2020	362231 (+6359)	[353558 - 370904]
30-10-2020	375085 (+6450)	[365602 - 384568]

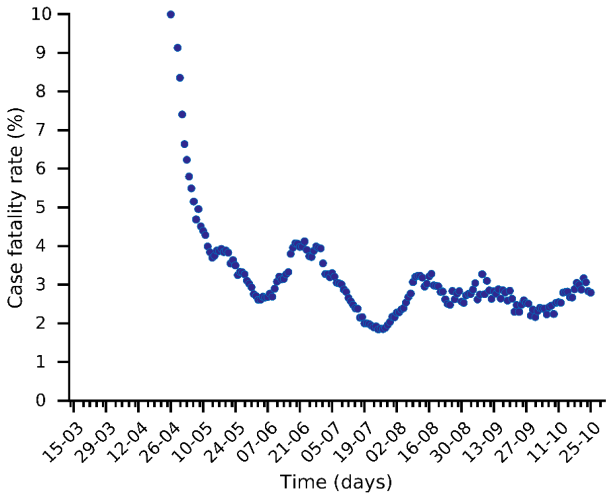
Current indicators

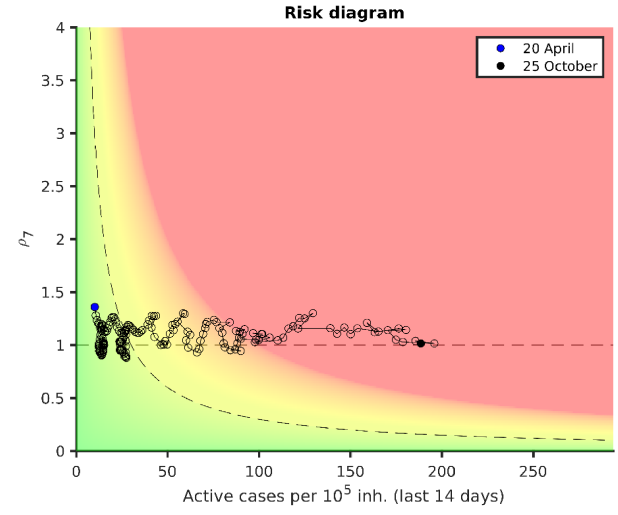
A_{14}	EPG	CFR
189	192	2.79 %

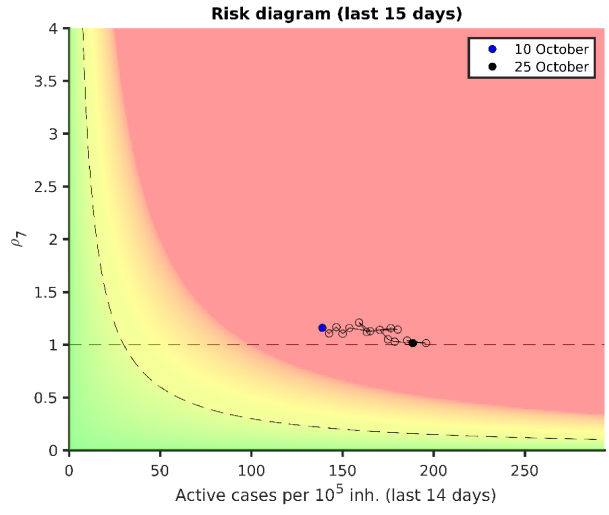




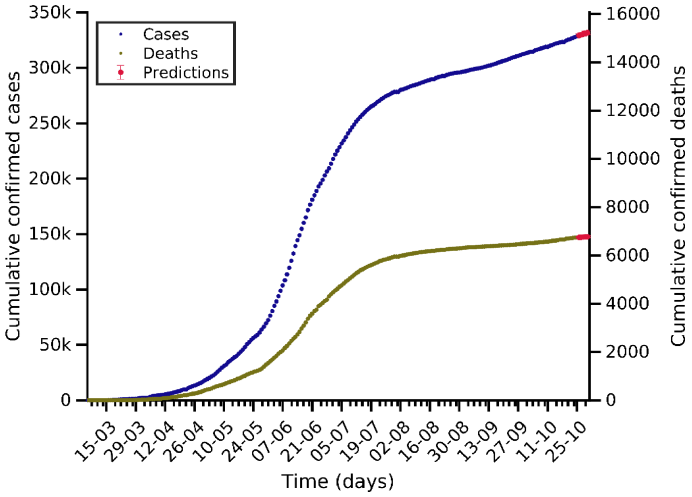








Pakistan 25-10-2020. Pop: 220.9M. Cumulative incidence: 149/10^5

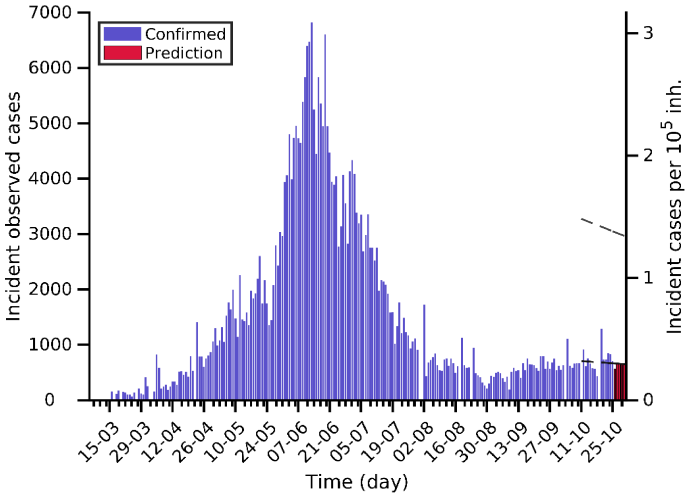


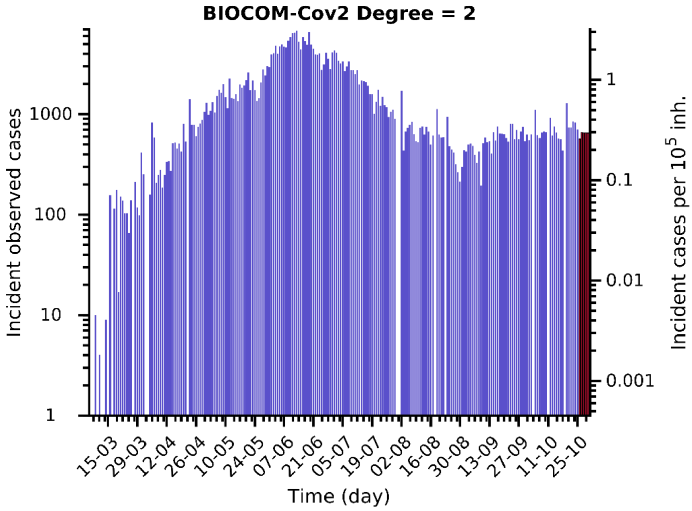
Predictions for next days

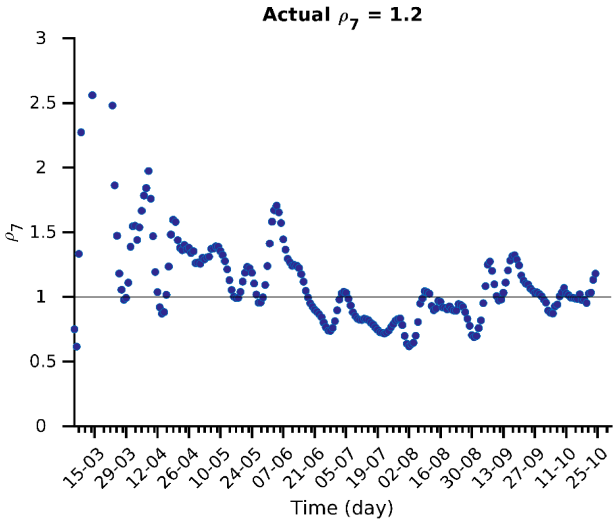
Day	Number of cases	95% Confidence Interval
26-10-2020	329169 (+567)	[328602 - 330873]
28-10-2020	330485 (+657)	[328718 - 332253]
30-10-2020	331790 (+651)	[329888 - 333692]

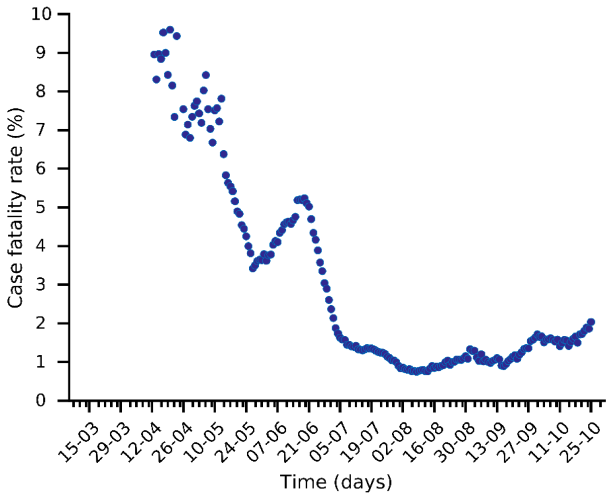
Current indicators

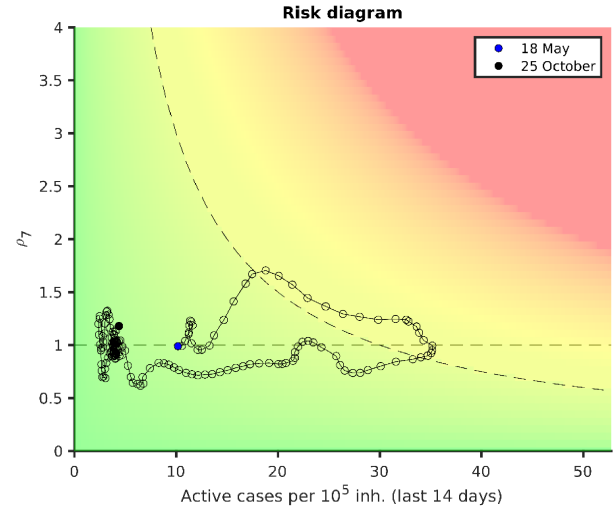
A_{14}	EPG	CFR
4	5	2.03 %

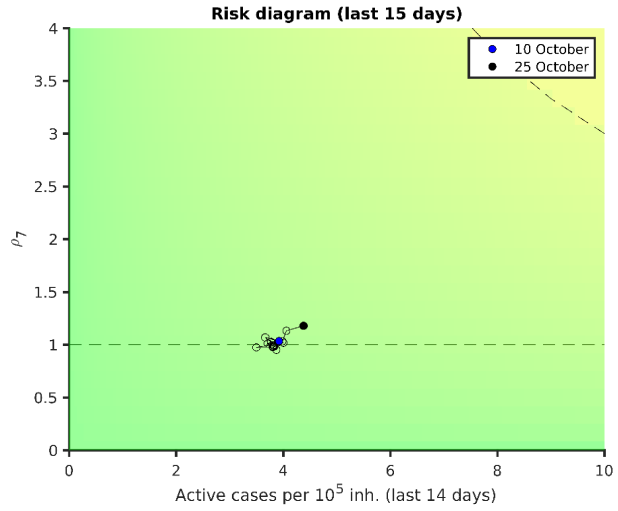




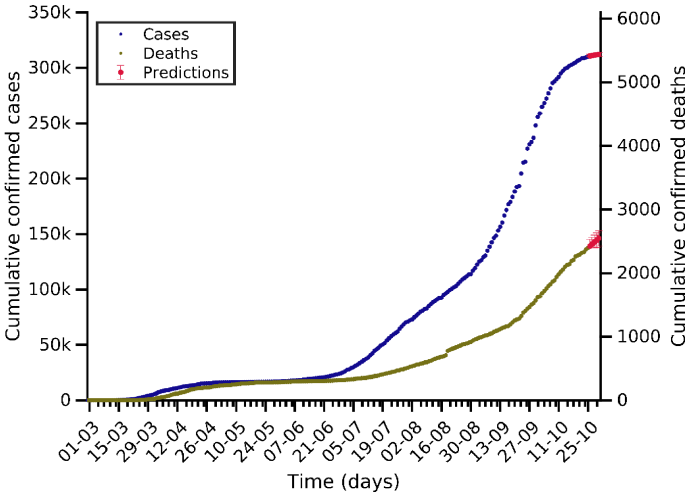








Israel 25-10-2020. Pop: 8.7M. Cumulative incidence: 3583/10^5

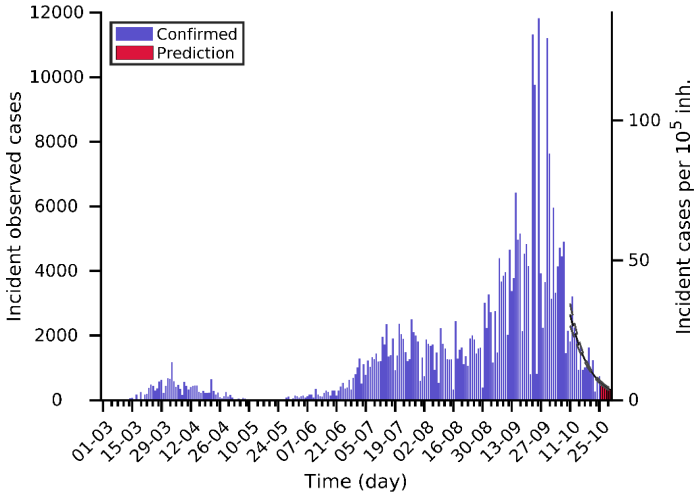


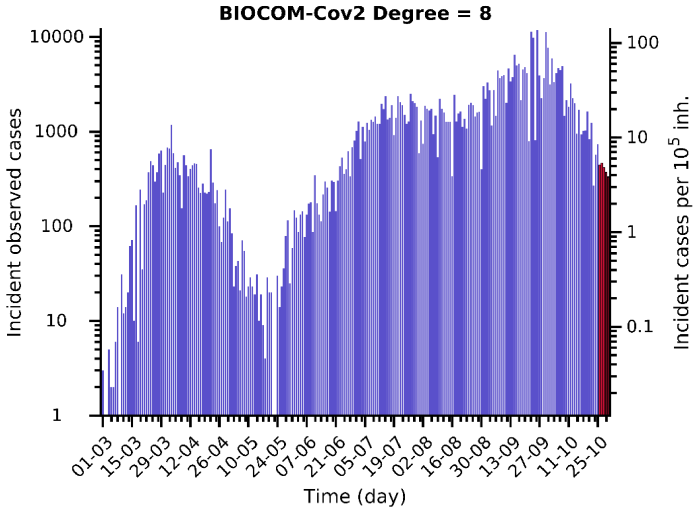
Predictions for next days

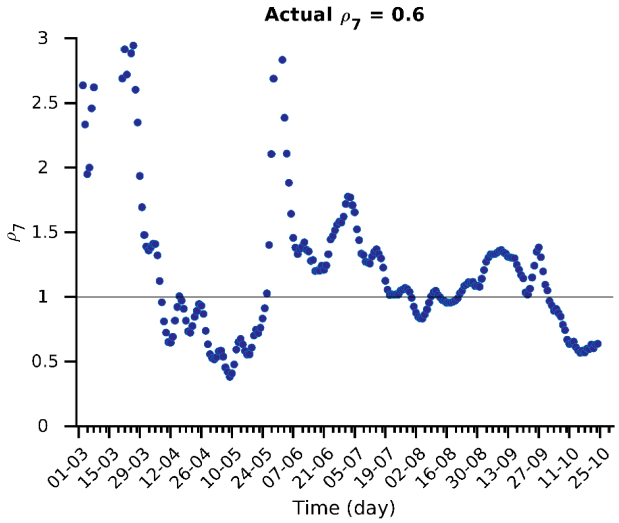
Day	Number of cases	95% Confidence Interval
26-10-2020	310592 (+444)	[310148 - 312351]
28-10-2020	311472 (+415)	[310148 - 313257]
30-10-2020	312175 (+332)	[310350 - 314000]

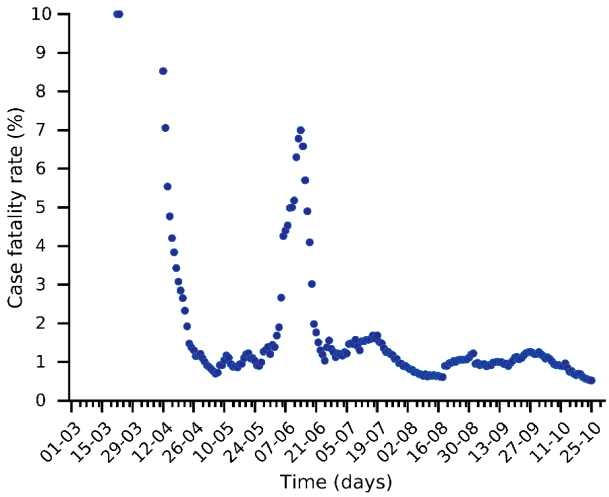
Current indicators

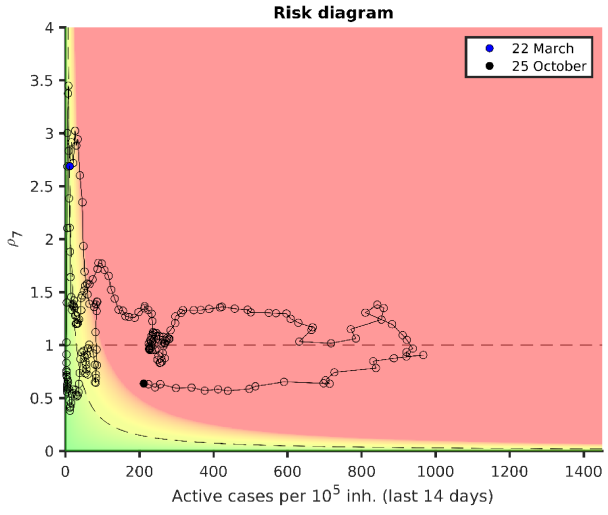
A_{14}	EPG	CFR
212	135	0.52 %

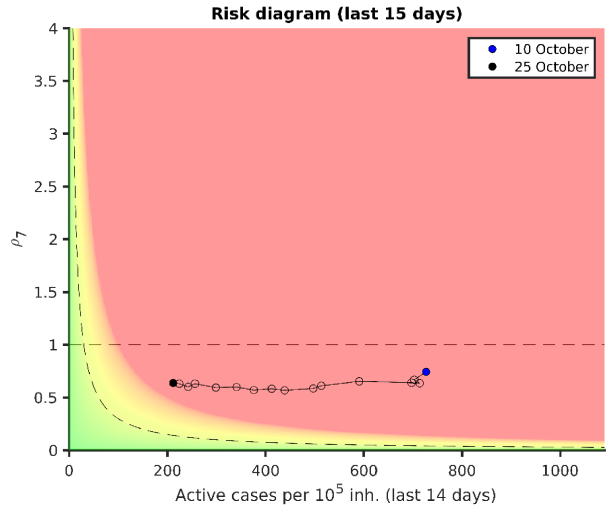




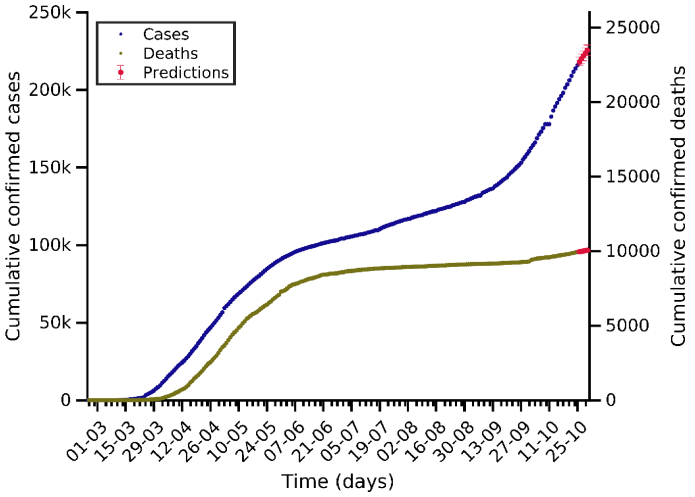








Canada 25-10-2020. Pop: 37.7M. Cumulative incidence: 573/10⁵

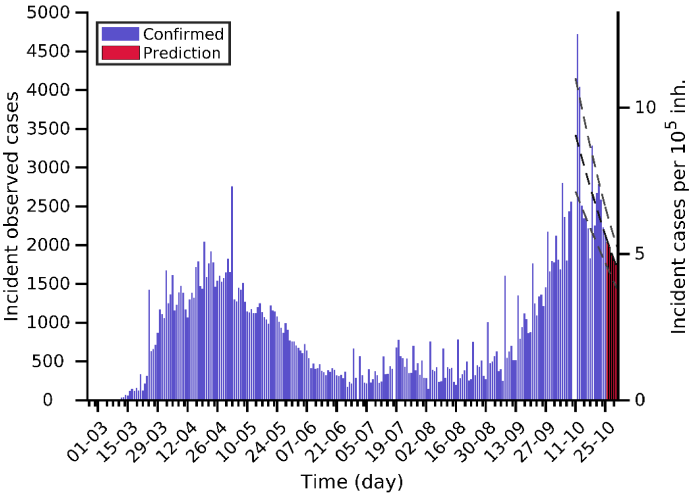


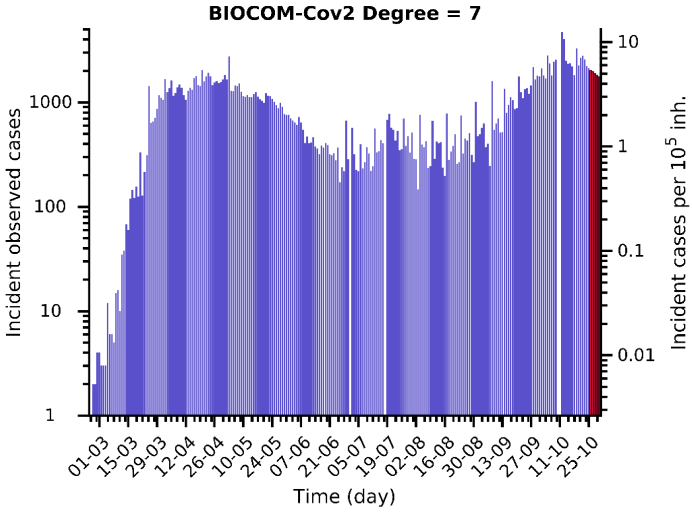
Predictions for next days

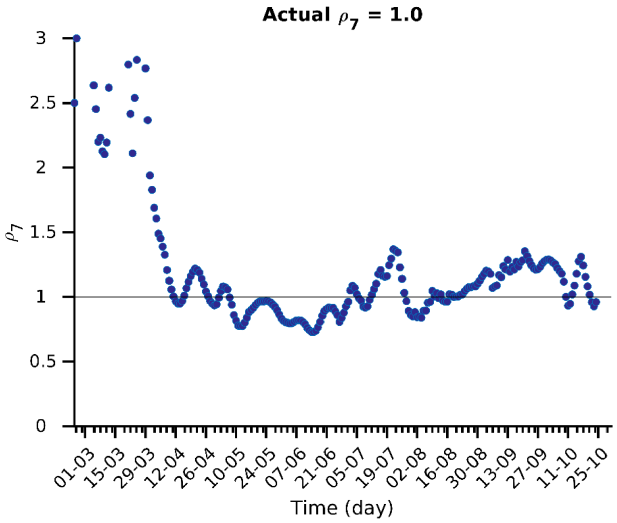
Day	Number of cases	95% Confidence Interval
26-10-2020	218142 (+2038)	[216104 - 221248]
28-10-2020	222017 (+1900)	[218817 - 225216]
30-10-2020	225597 (+1754)	[222221 - 228973]

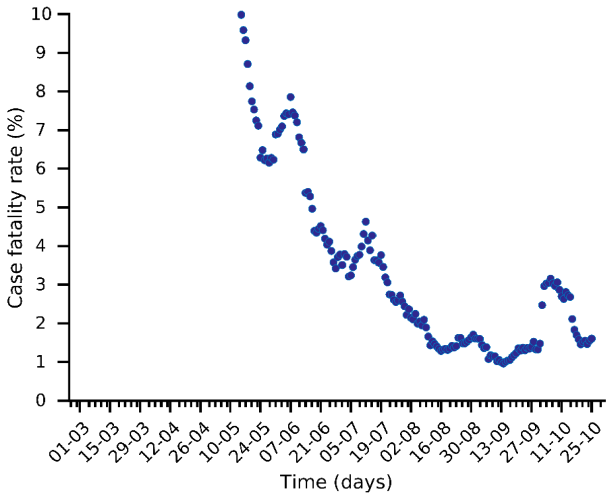
Current indicators

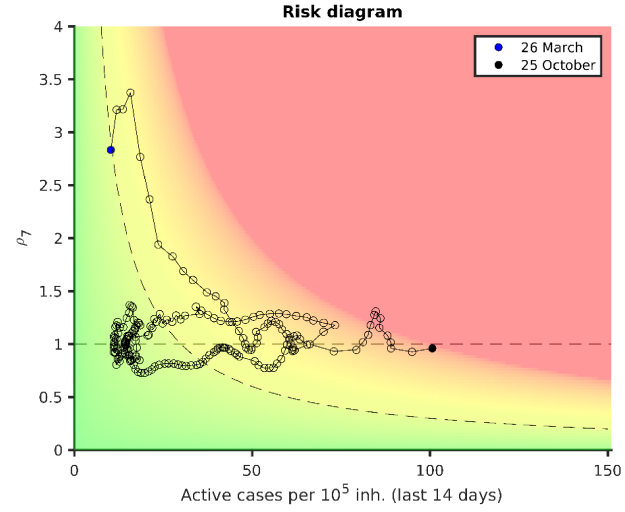
A_{14}	EPG	CFR
101	97	1.60 %

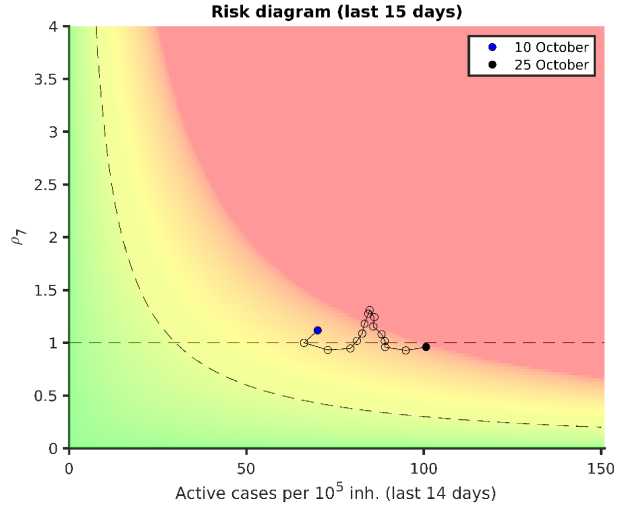




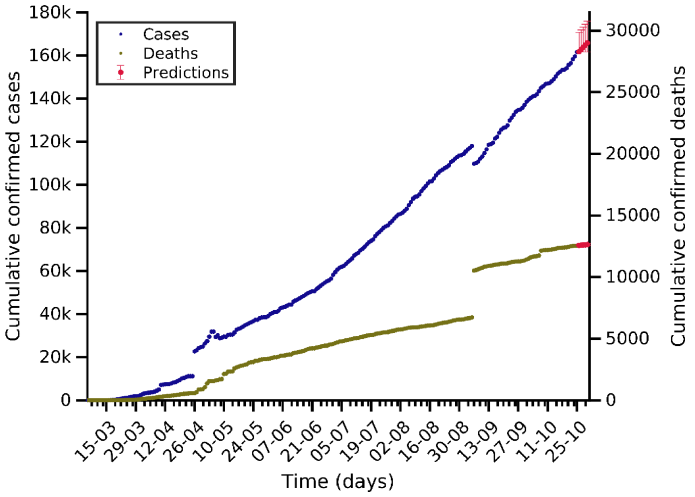








Ecuador 25-10-2020. Pop: 17.6M. Cumulative incidence: 916/10^5

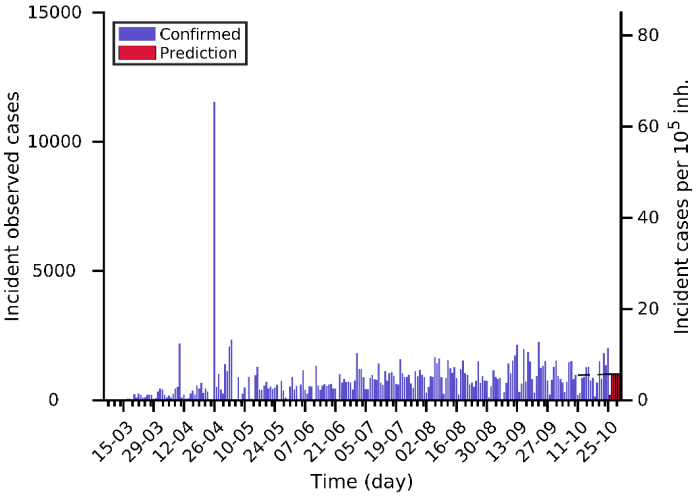


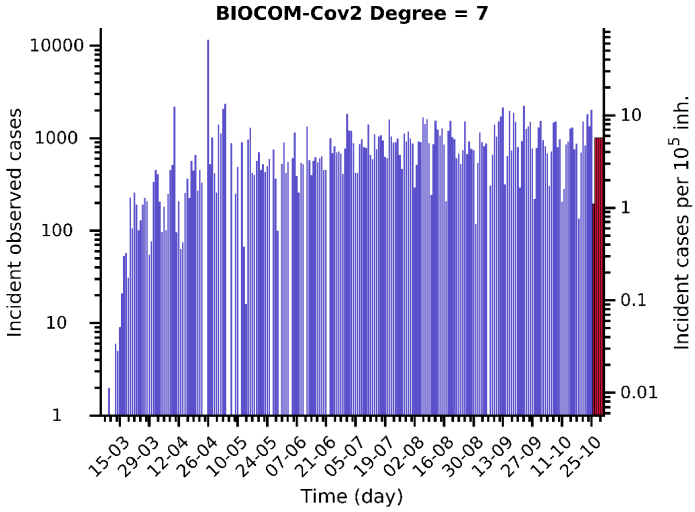
Predictions for next days

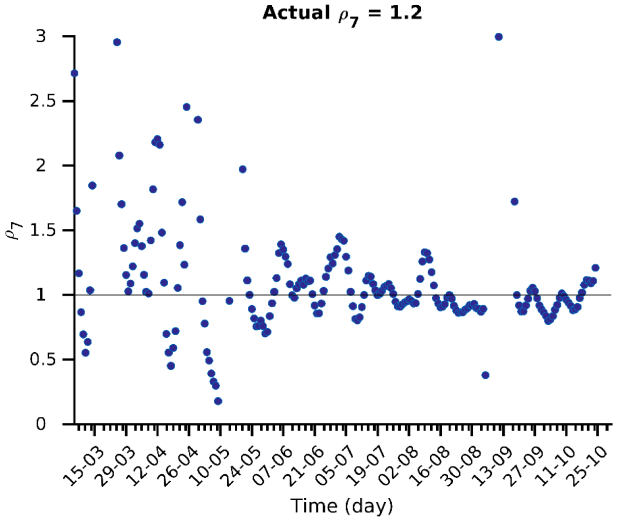
Day	Number of cases	95% Confidence Interval
26-10-2020	161829 (+194)	[161635 - 170785]
28-10-2020	163840 (+1007)	[161635 - 173156]
30-10-2020	165860 (+1011)	[161635 - 175951]

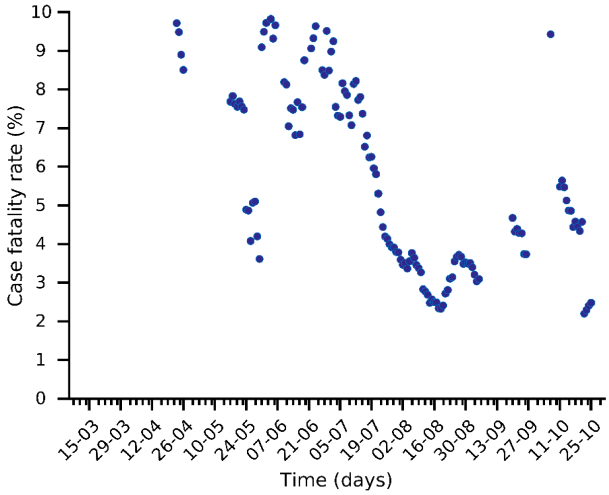
Current indicators

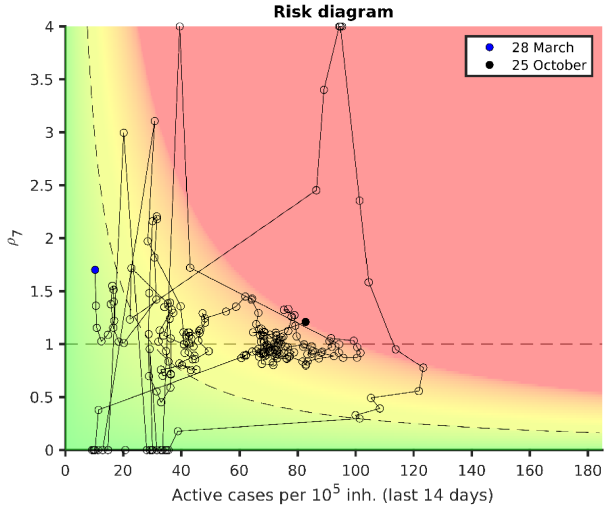
A_{14}	EPG	CFR
83	100	2.48 %

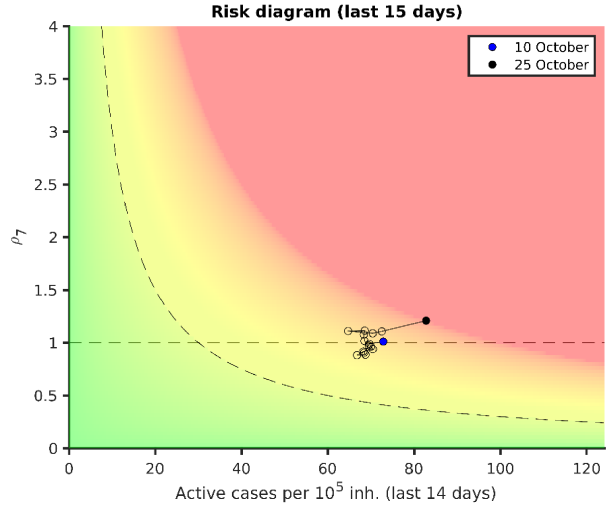




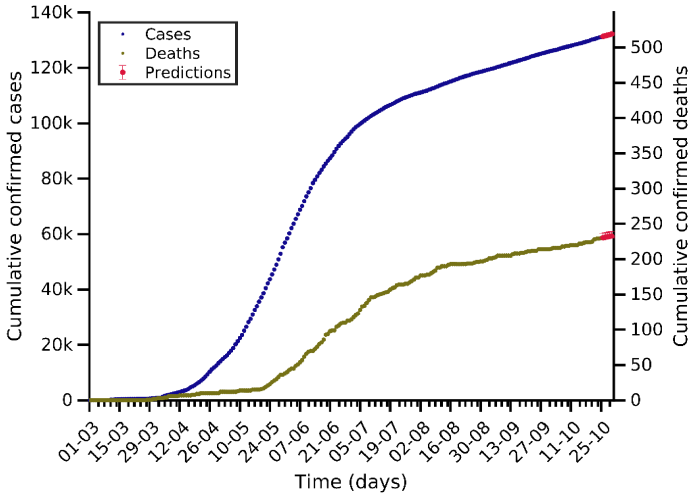








Qatar 25-10-2020. Pop: 2.9M. Cumulative incidence: 4553/10⁵

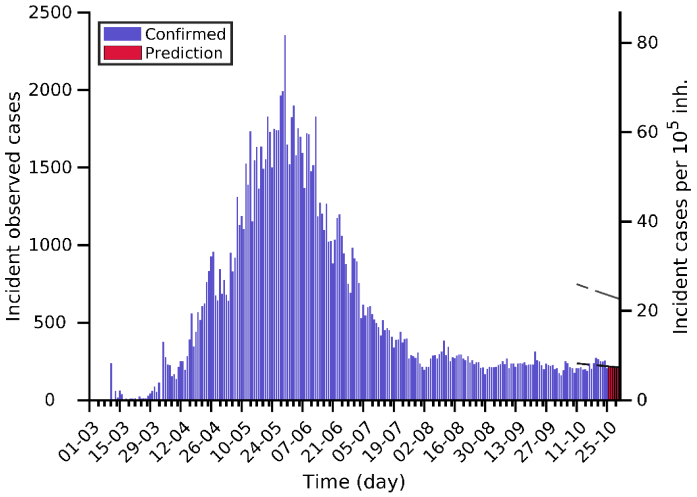


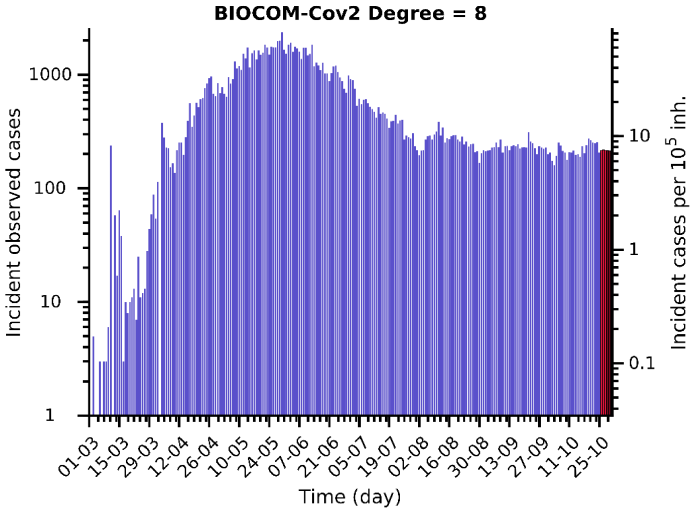
Predictions for next days

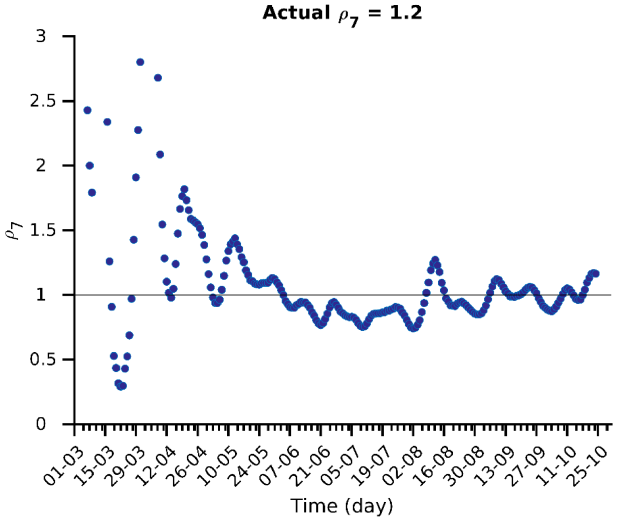
Day	Number of cases	95% Confidence Interval
26-10-2020	131385 (+215)	[131170 - 131768]
28-10-2020	131817 (+216)	[131419 - 132215]
30-10-2020	132245 (+213)	[131817 - 132673]

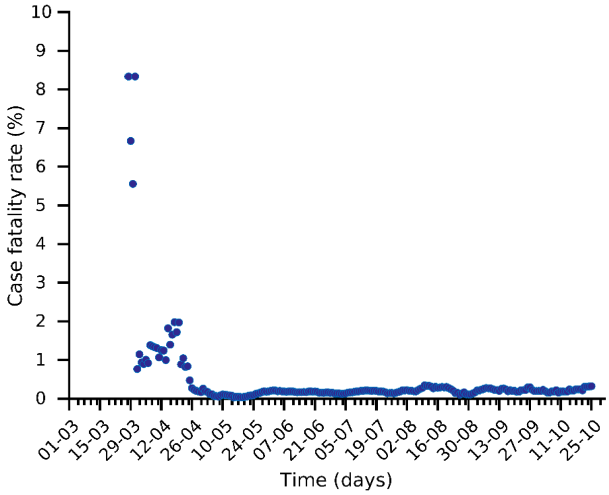
Current indicators

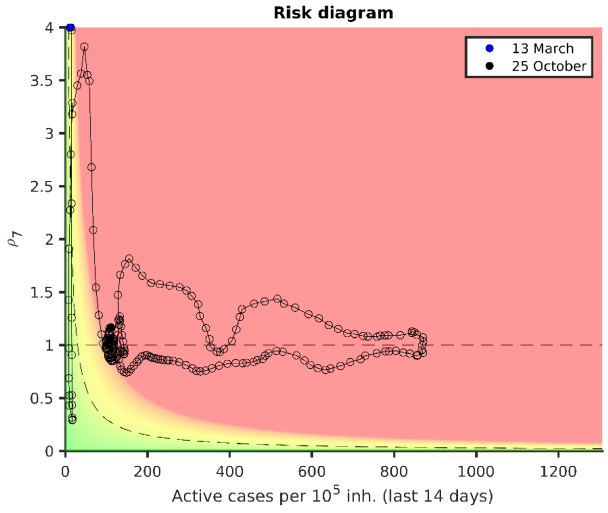
A_{14}	EPG	CFR
111	129	0.32 %

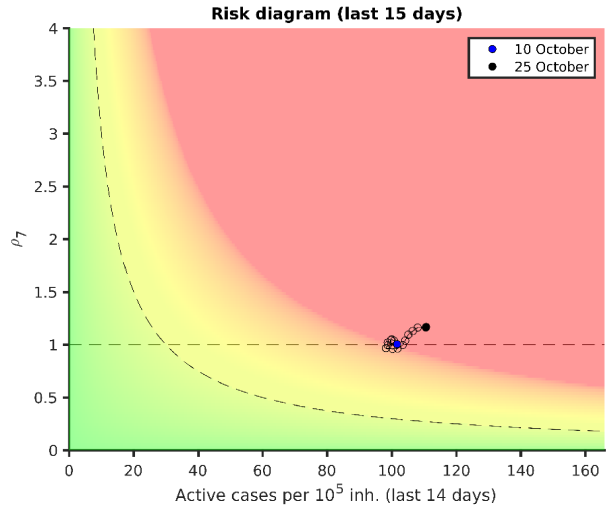




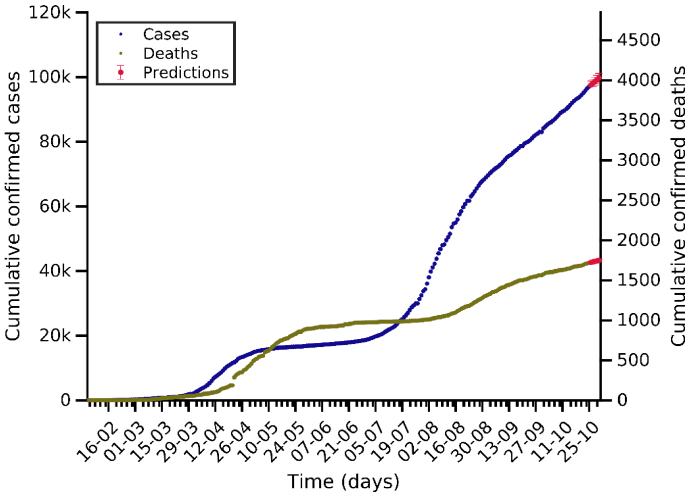








Japan 25-10-2020. Pop: 126.5M. Cumulative incidence: $77/10^5$

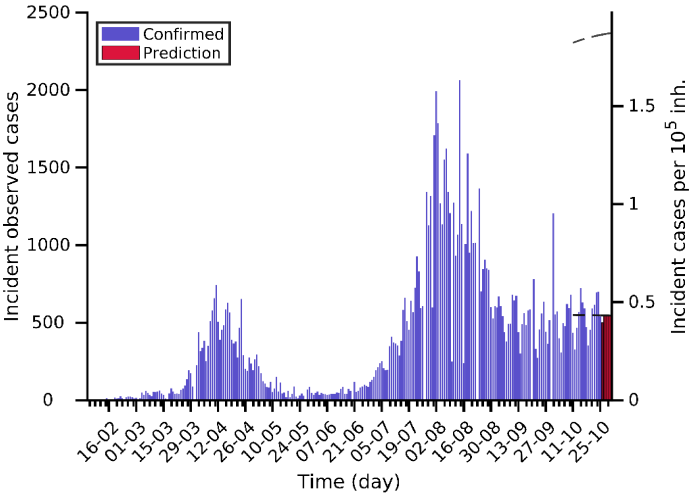


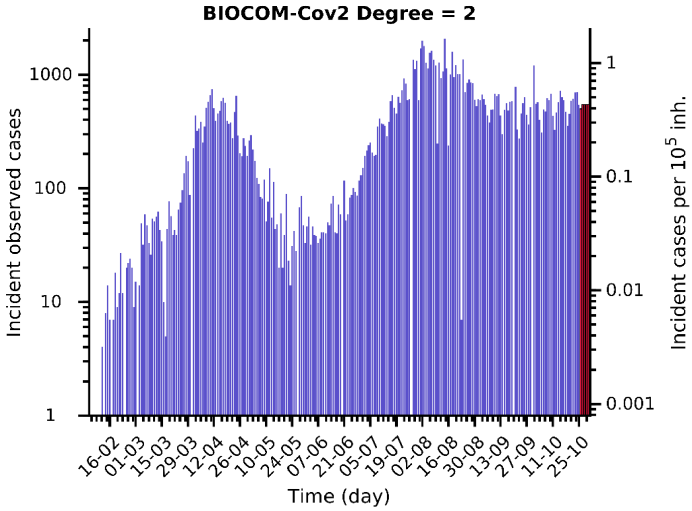
Predictions for next days

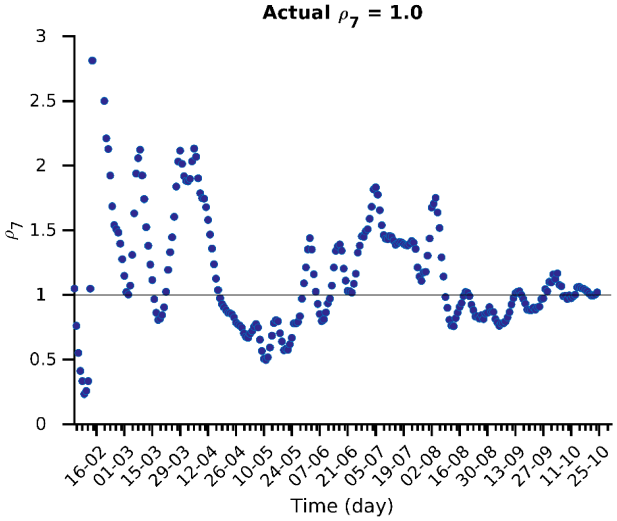
Day	Number of cases	95% Confidence Interval
26-10-2020	97574 (+500)	[97074 - 98789]
28-10-2020	98666 (+546)	[97403 - 99929]
30-10-2020	99756 (+545)	[98391 - 101121]

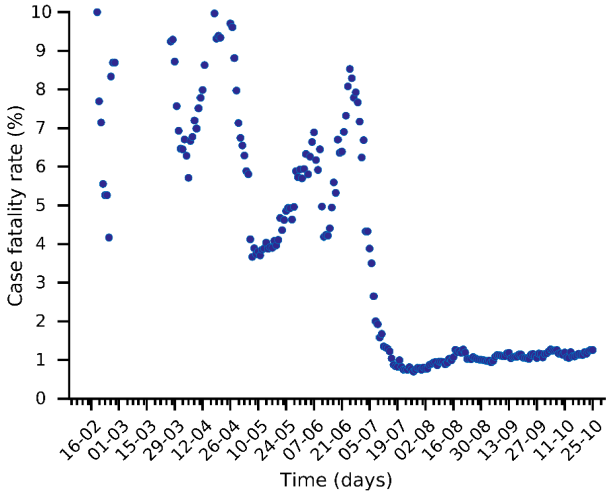
Current indicators

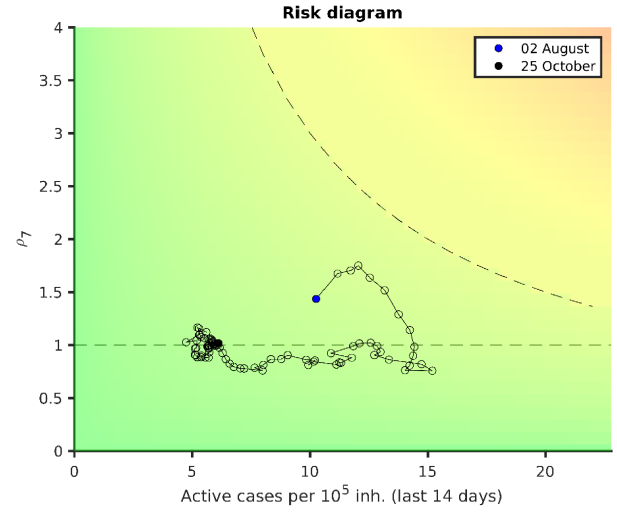
A_{14}	EPG	CFR
6	6	1.26 %

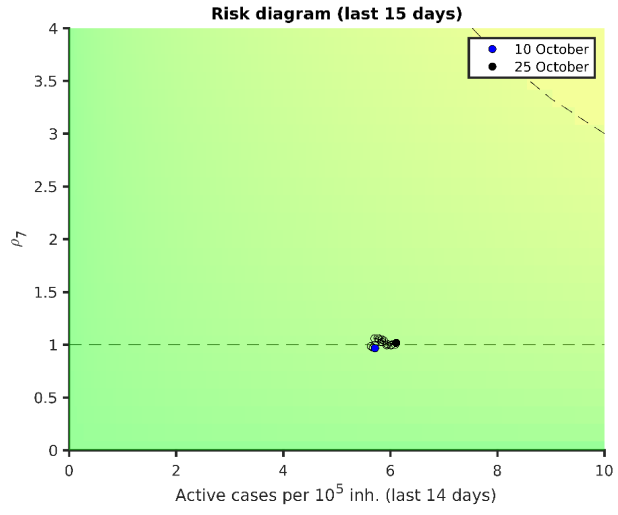




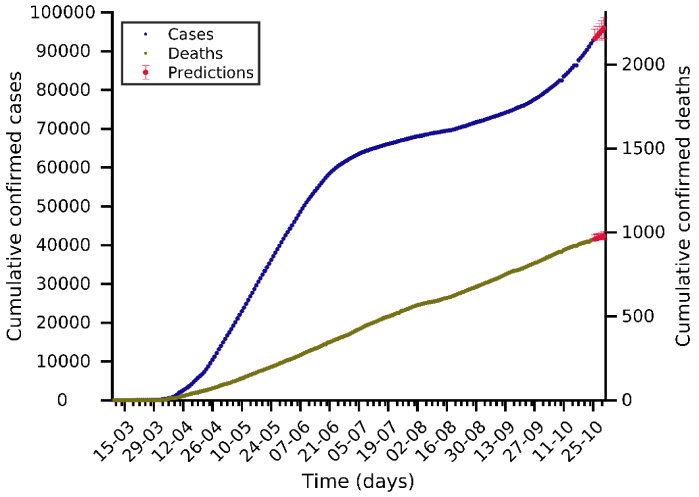








Belarus 25-10-2020. Pop: 9.4M. Cumulative incidence: 982/10⁵

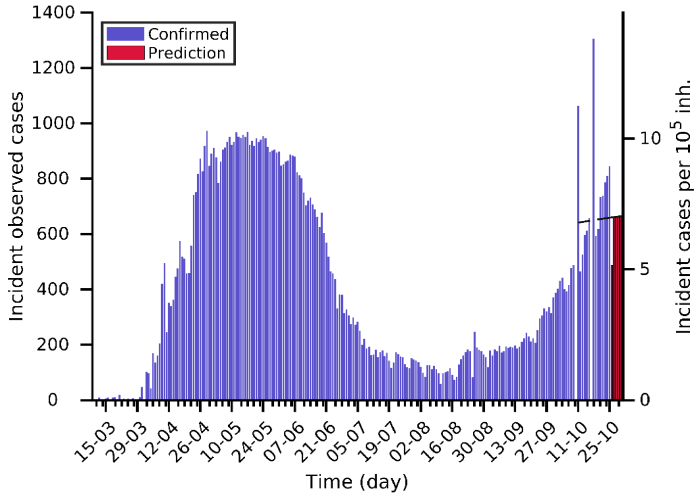


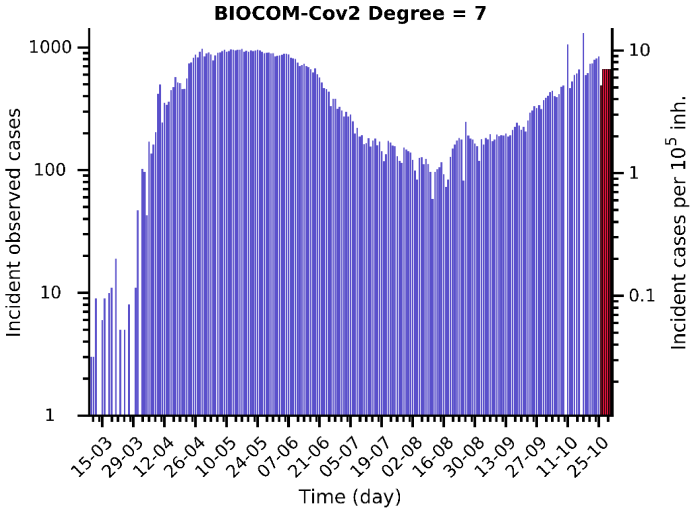
Predictions for next days

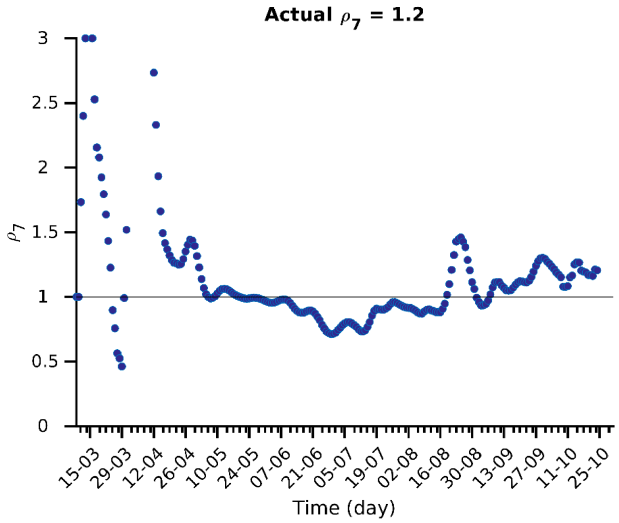
Day	Number of cases	95% Confidence Interval
26-10-2020	93310 (+487)	[92823 - 95708]
28-10-2020	94634 (+663)	[92823 - 97128]
30-10-2020	95962 (+665)	[93260 - 98664]

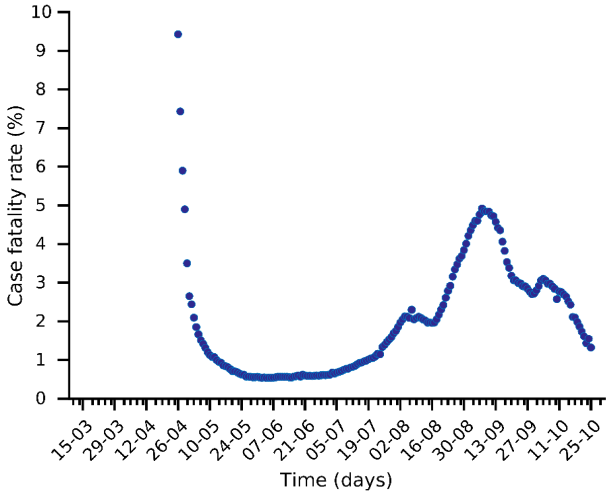
Current indicators

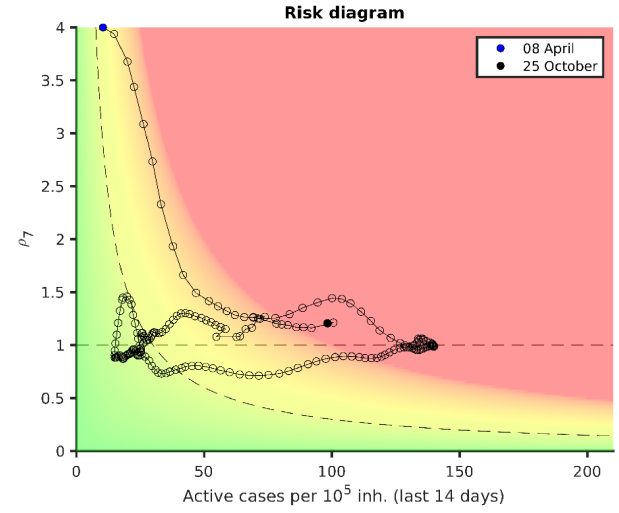
A_{14}	EPG	CFR
98	119	1.32 %

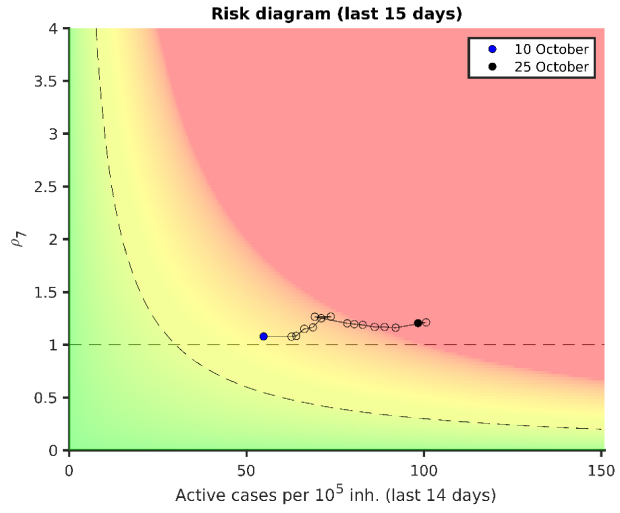




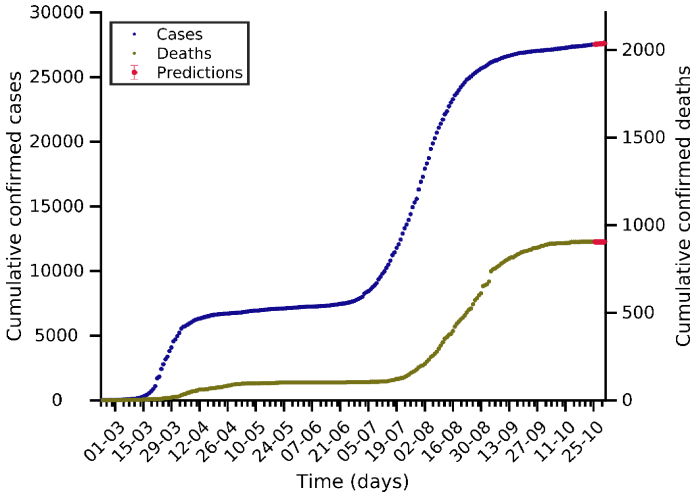








Australia 25-10-2020. Pop: 25.5M. Cumulative incidence: 108/10⁵

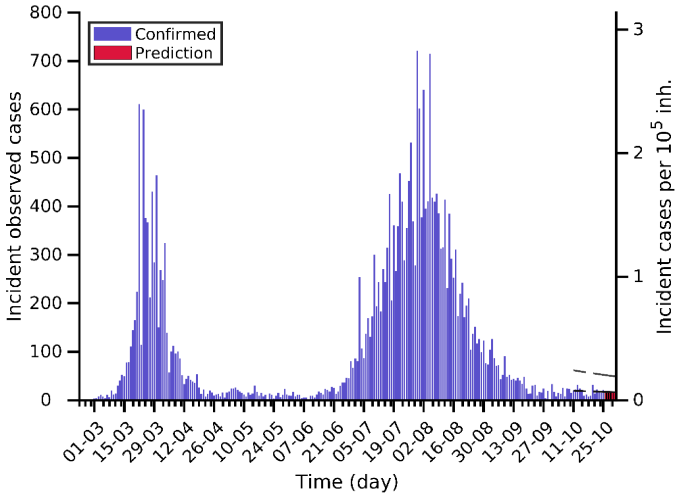


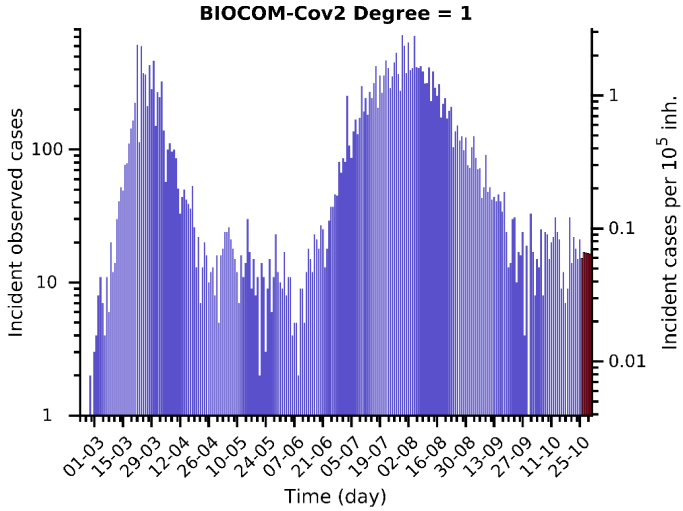
Predictions for next days

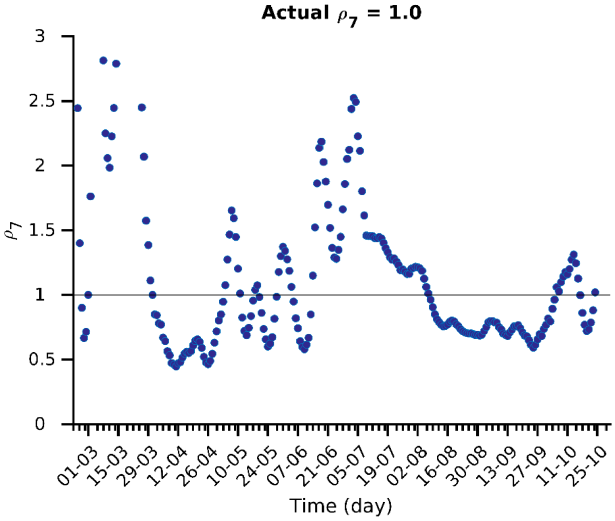
Day	Number of cases	95% Confidence Interval
26-10-2020	27535 (+15)	[27520 - 27576]
28-10-2020	27569 (+17)	[27527 - 27611]
30-10-2020	27602 (+16)	[27557 - 27647]

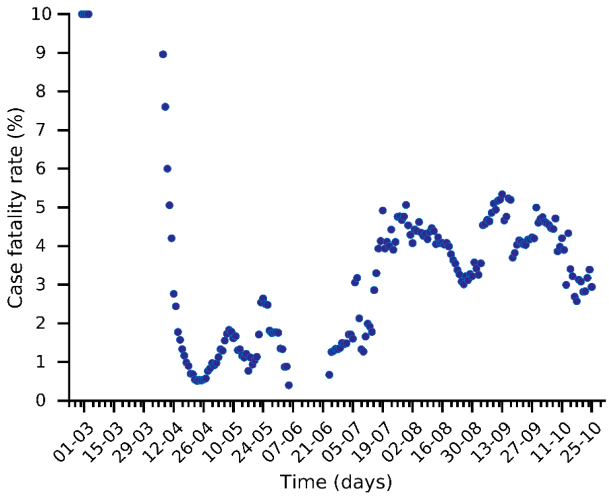
Current indicators

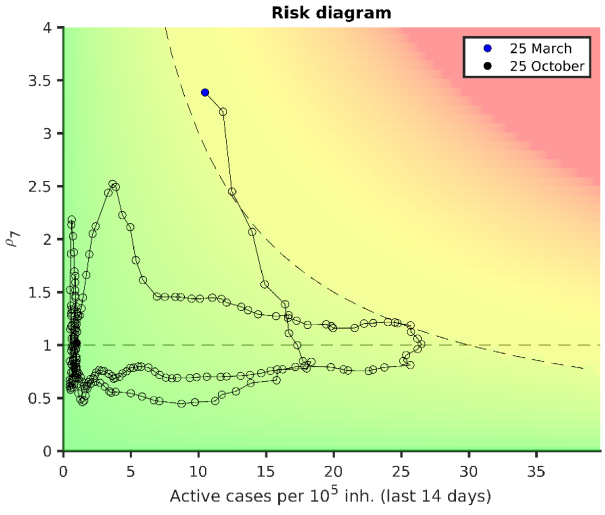
A_{14}	EPG	CFR
1	1	2.94 %

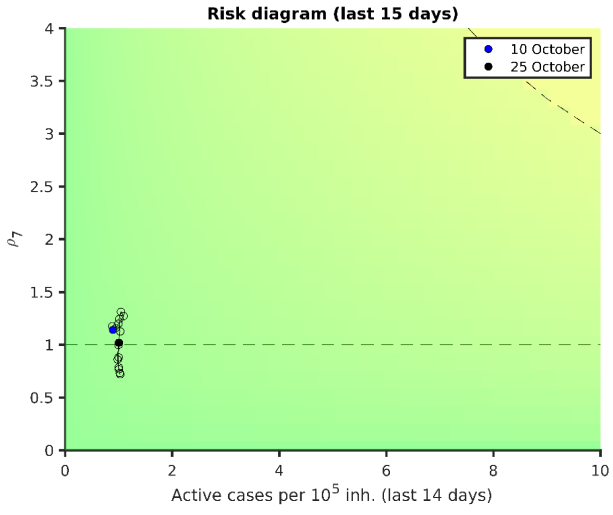




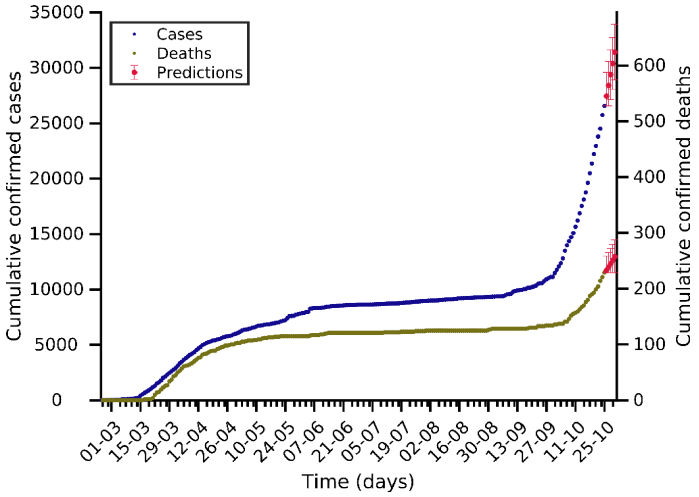








Malaysia 25-10-2020. Pop: 32.4M. Cumulative incidence: 82/10⁵

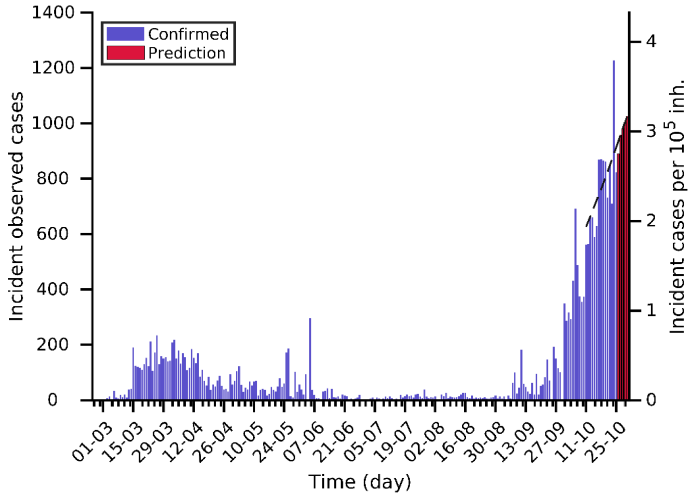


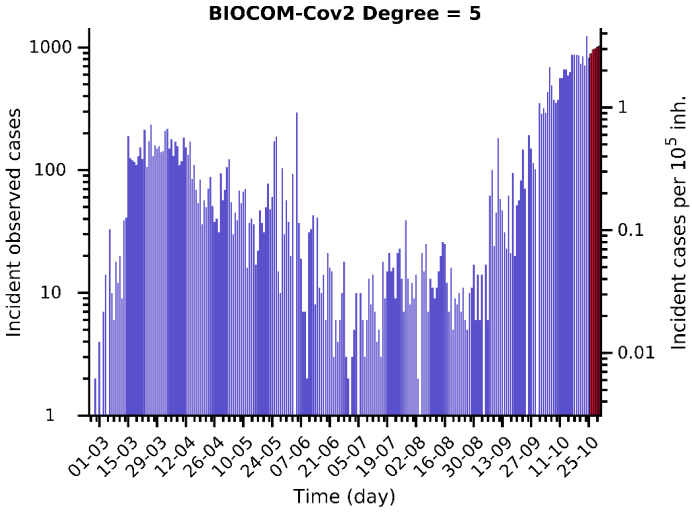
Predictions for next days

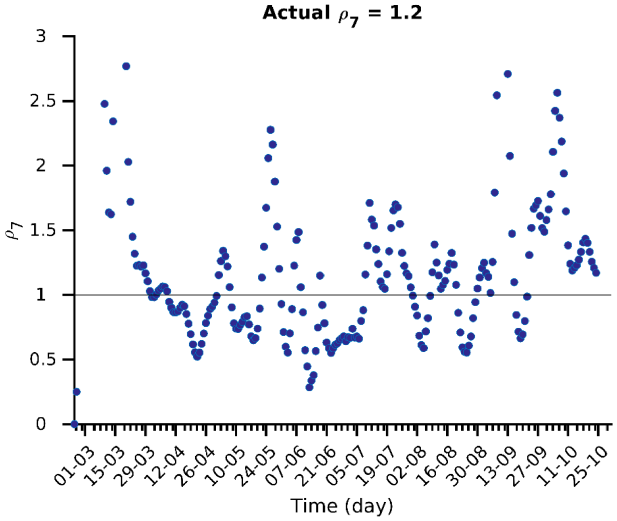
Day	Number of cases	95% Confidence Interval
26-10-2020	27454 (+889)	[26565 - 29584]
28-10-2020	29392 (+980)	[27151 - 31632]
30-10-2020	31419 (+1025)	[28914 - 33925]

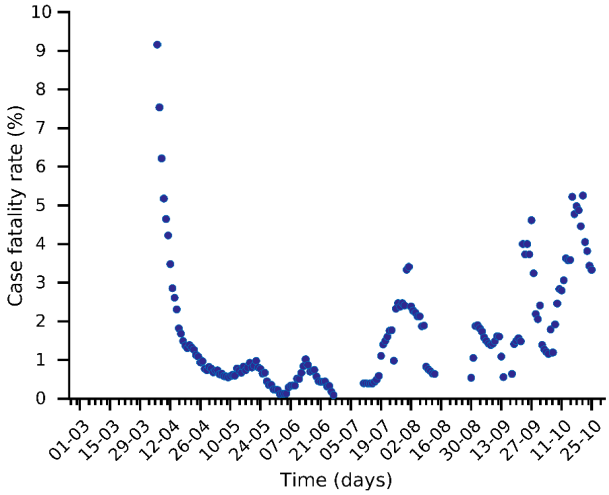
Current indicators

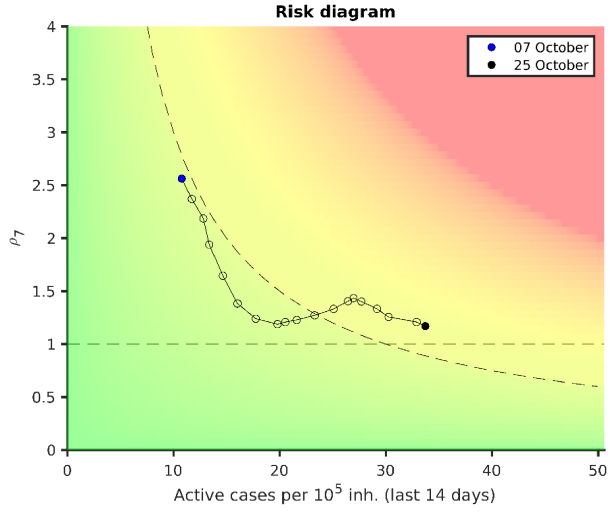
A_{14}	EPG	CFR
34	39	3.33 %

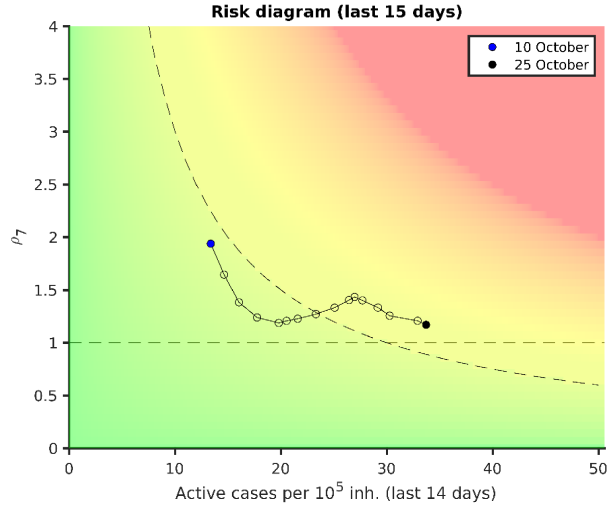




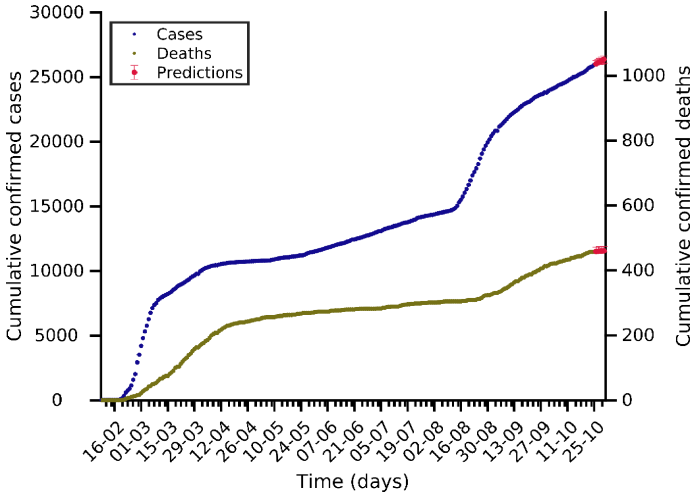








South Korea 25-10-2020. Pop: 51.3M. Cumulative incidence: 51/10^5

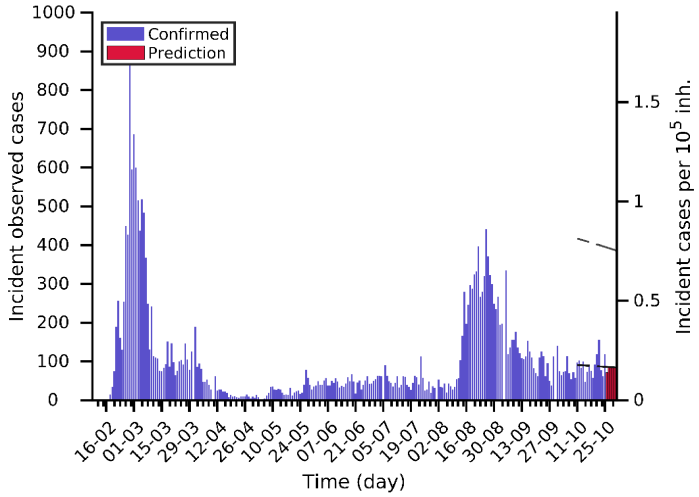


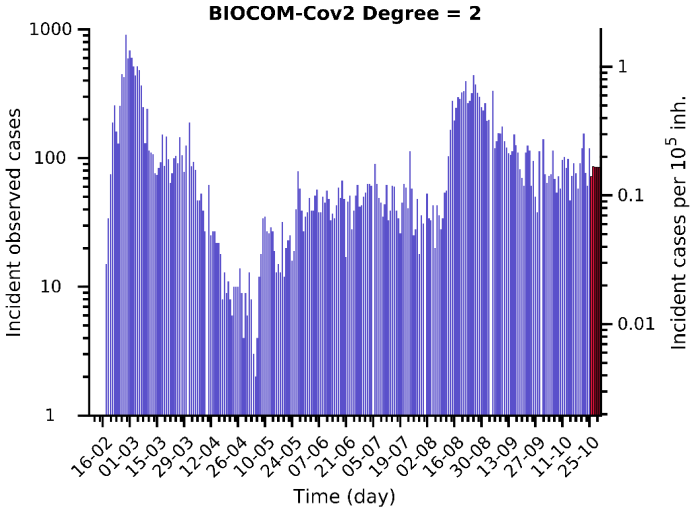
Predictions for next days

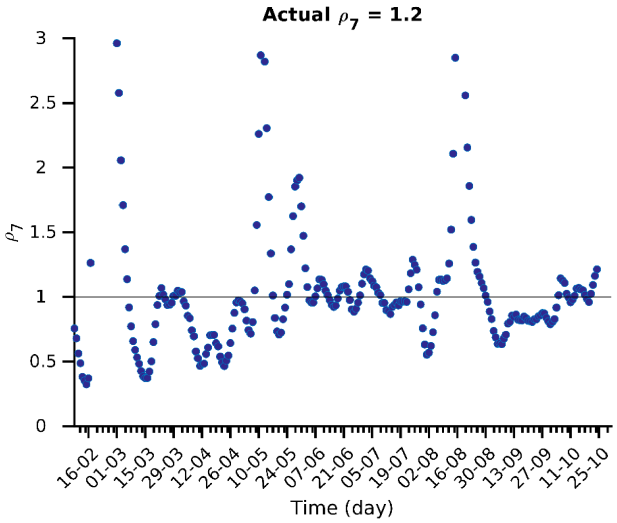
Day	Number of cases	95% Confidence Interval
26-10-2020	26027 (+72)	[25955 - 26272]
28-10-2020	26198 (+85)	[25955 - 26452]
30-10-2020	26367 (+85)	[26094 - 26641]

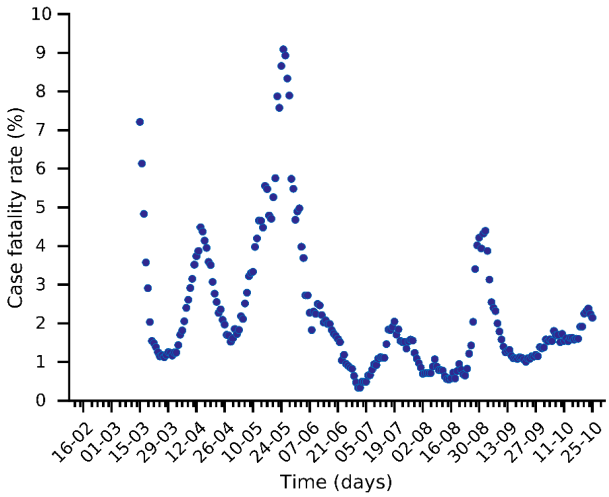
Current indicators

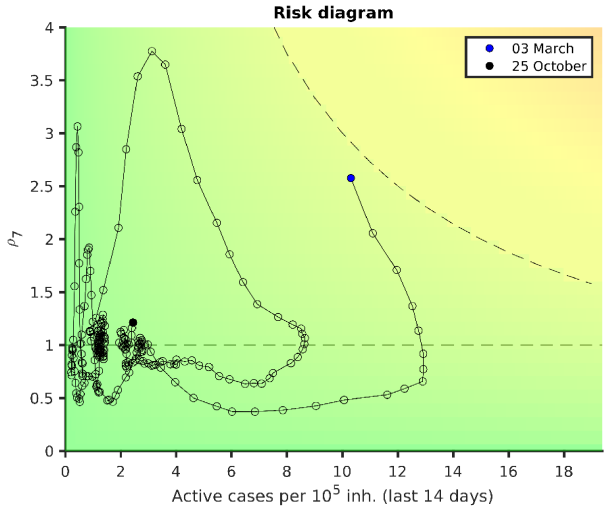
A_{14}	EPG	CFR
2	3	2.14 %

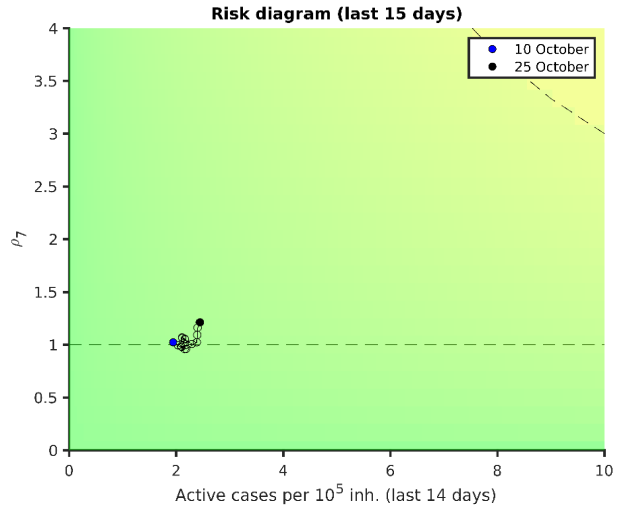










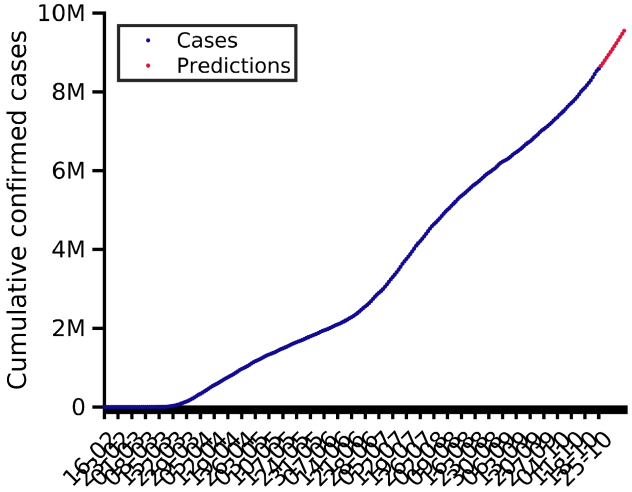


(3) Analysis and prediction of COVID-19 for some USA states and counties

Forecasts of the USA are done using Facebook AI model[1]

[1] https://ai.facebook.com/research/publications/neural-relational-autoregression-for-high-resolution-covid-19-forecasting/

United States 25-10-2020. Pop: 331.4M. Cumulative incidence: 2591/10^5

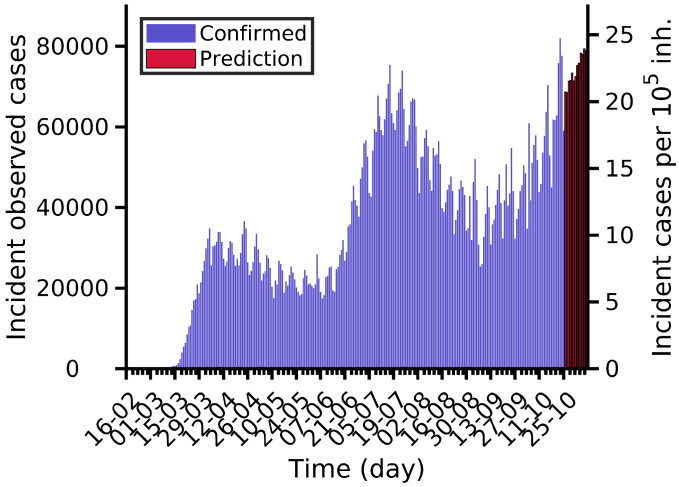


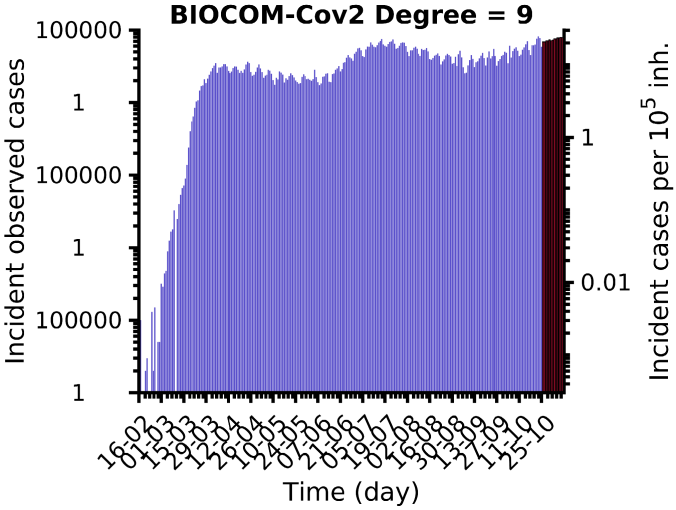
Predictions for next days

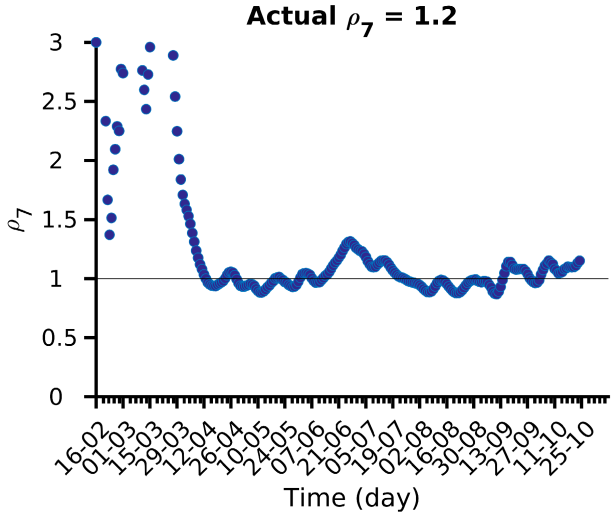
Day	Number of cases
26-10-2020	8654630 (+68670)
28-10-2020	8794468 (+71334)
30-10-2020	8939354 (+73360)

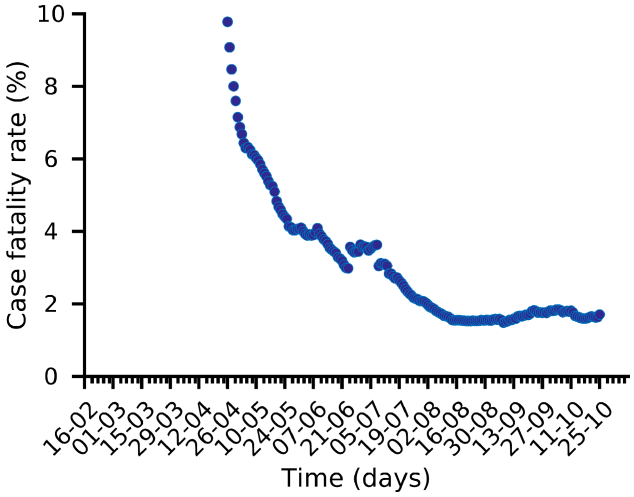
Current indicators

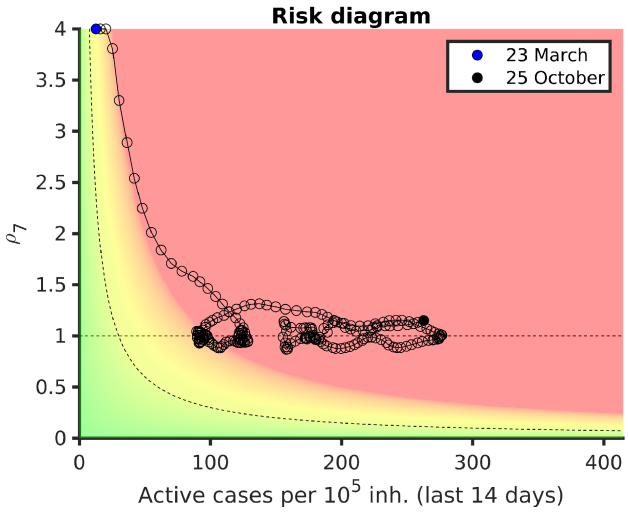
A_{14}	EPG	CFR
263	302	1.71 %

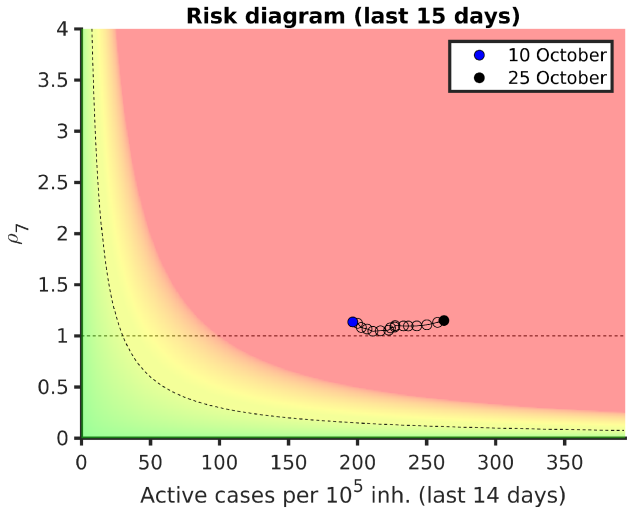




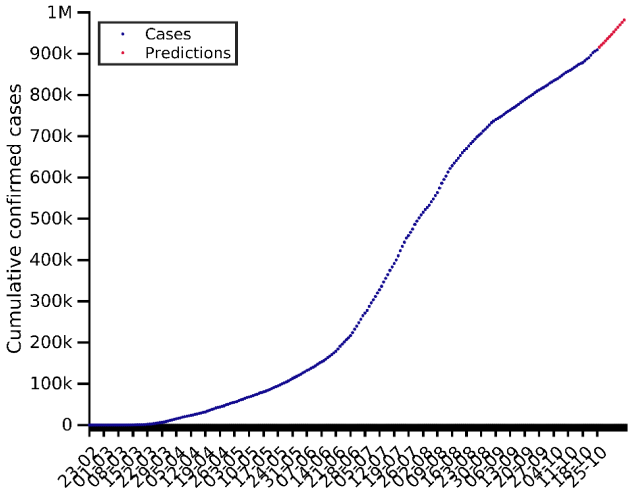








California 25-10-2020. Pop: 39.5M. Cumulative incidence: 2301/10^5

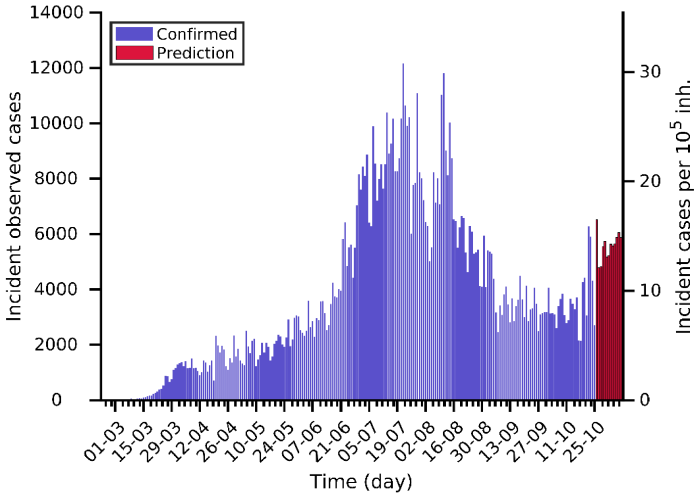


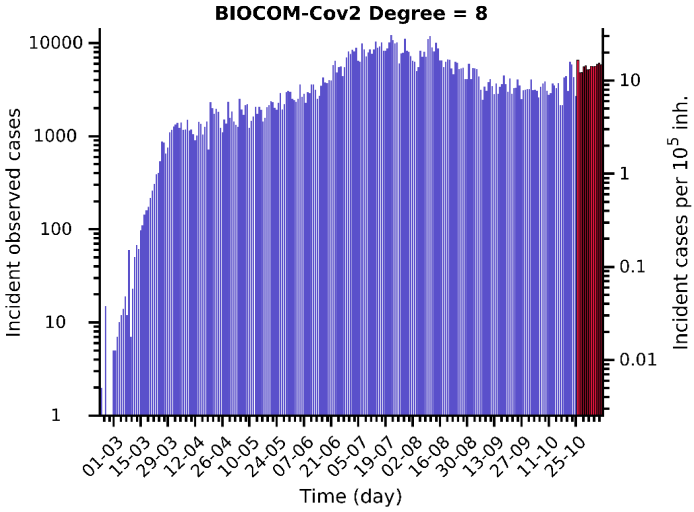
Predictions for next days

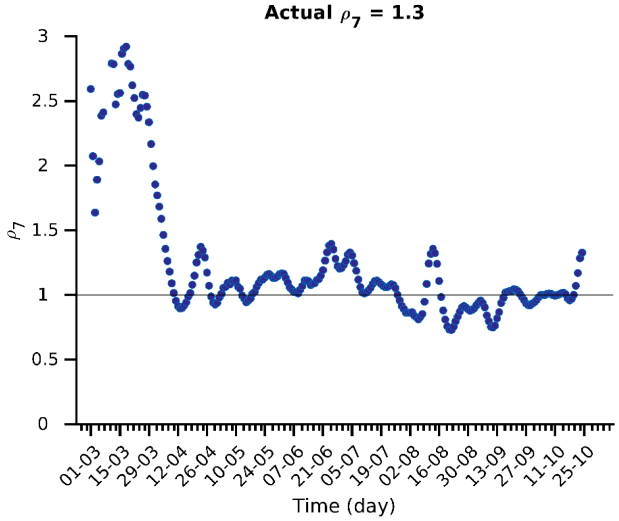
Day	Number of cases
26-10-2020	915863 (+6519)
28-10-2020	925474 (+4824)
30-10-2020	936757 (+5736)

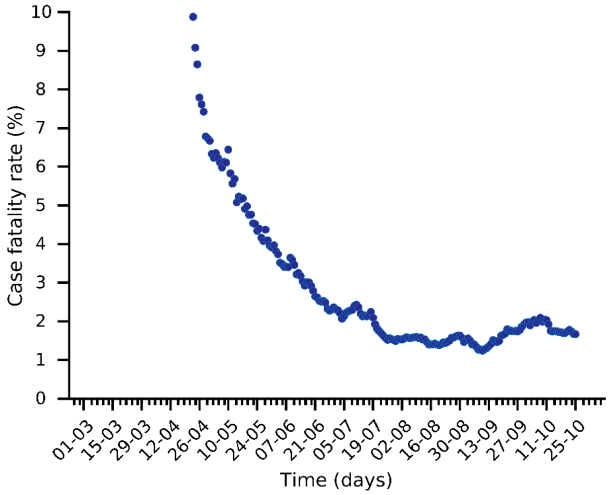
Current indicators

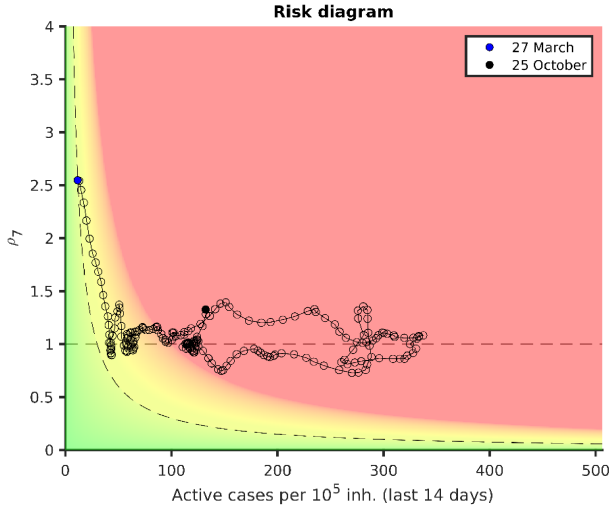
A_{14}	EPG	CFR
132	176	1.67 %

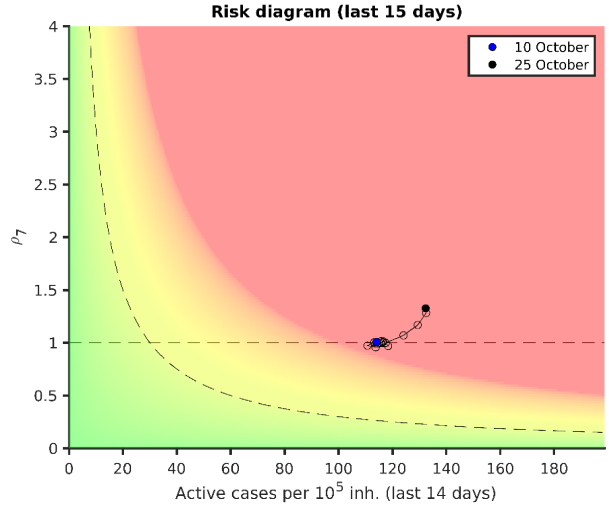




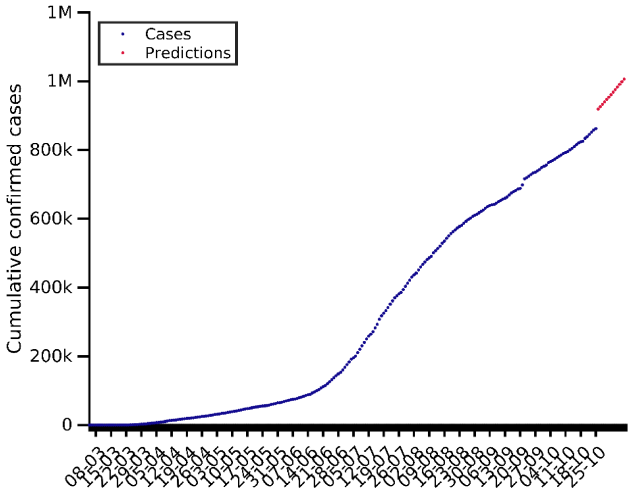








Texas 25-10-2020. Pop: 29.0M. Cumulative incidence: 2974/10⁵

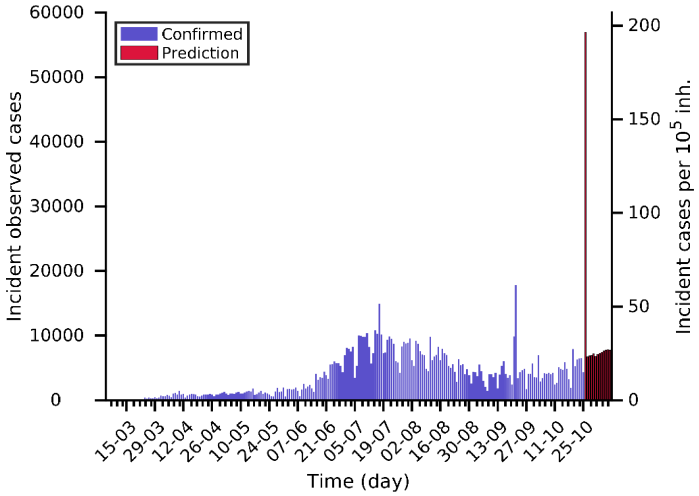


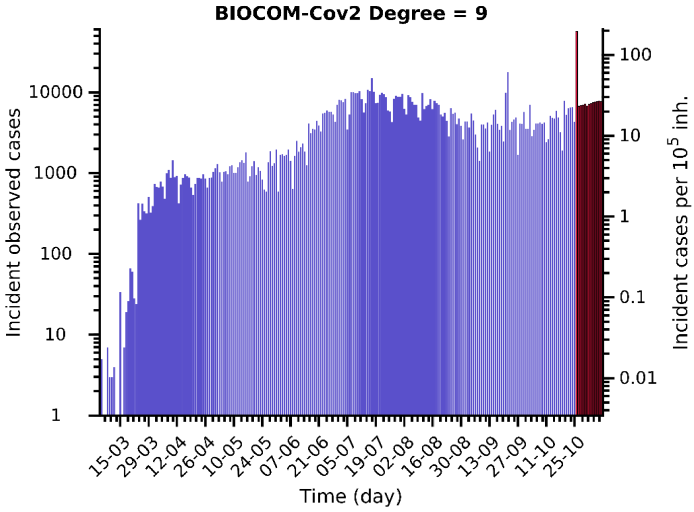
Predictions for next days

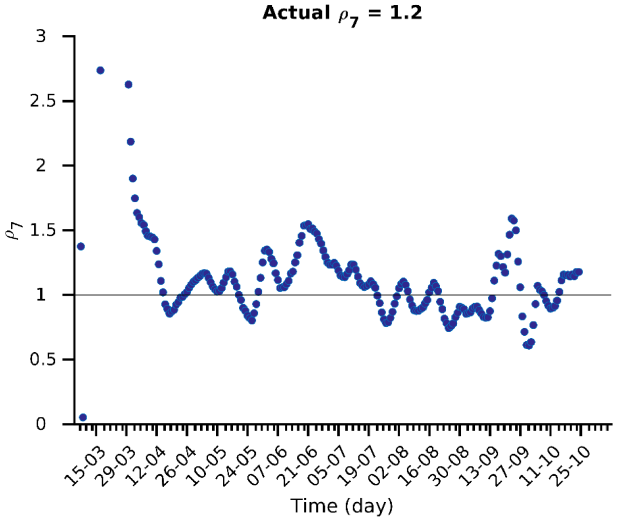
Day	Number of cases
26-10-2020	919322 (+56947)
28-10-2020	932875 (+6841)
30-10-2020	946985 (+7190)

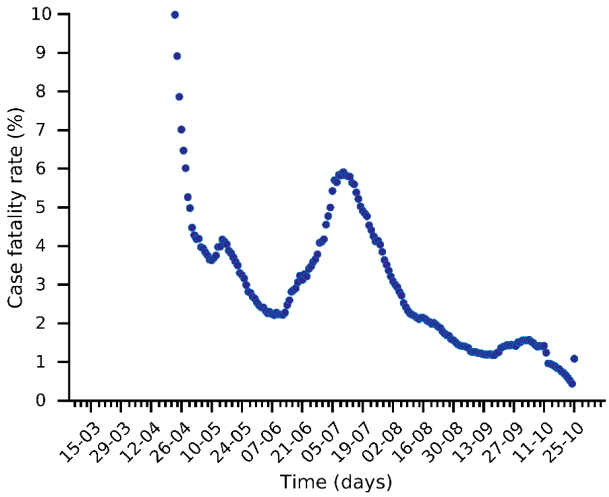
Current indicators

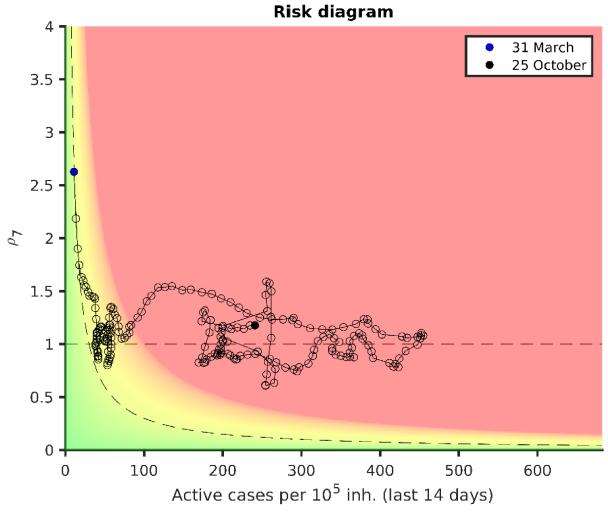
A_{14}	EPG	CFR
241	284	1.08 %

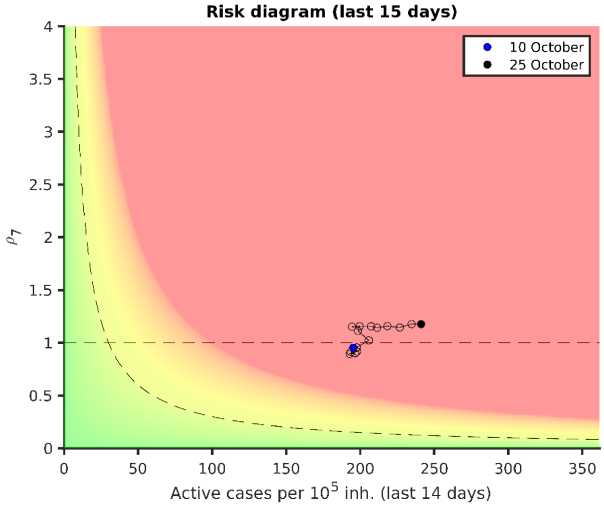




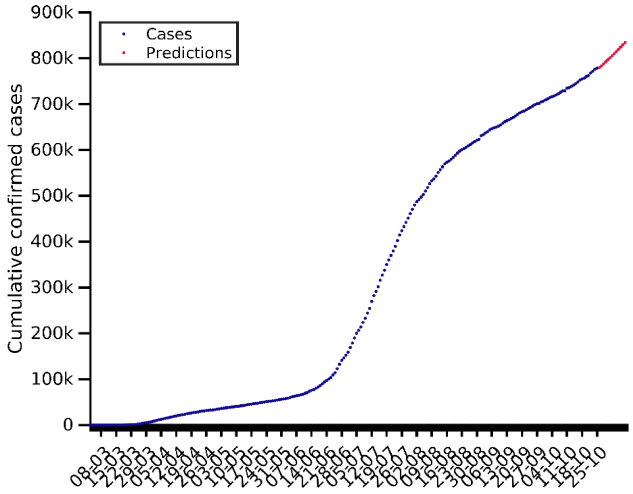








Florida 25-10-2020. Pop: 21.5M. Cumulative incidence: $3625/10^5$

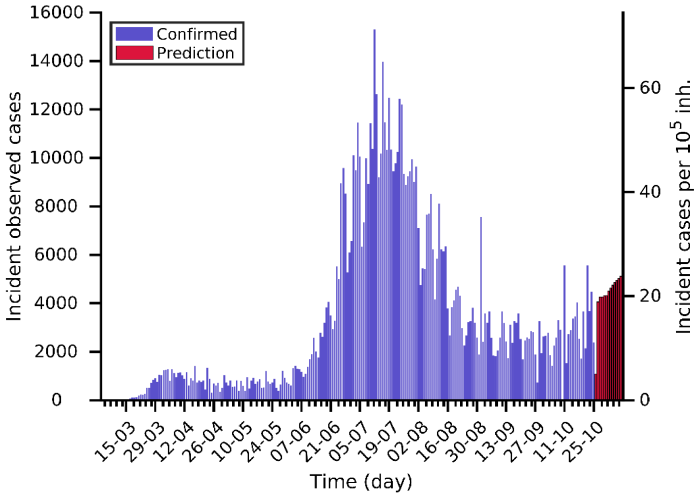


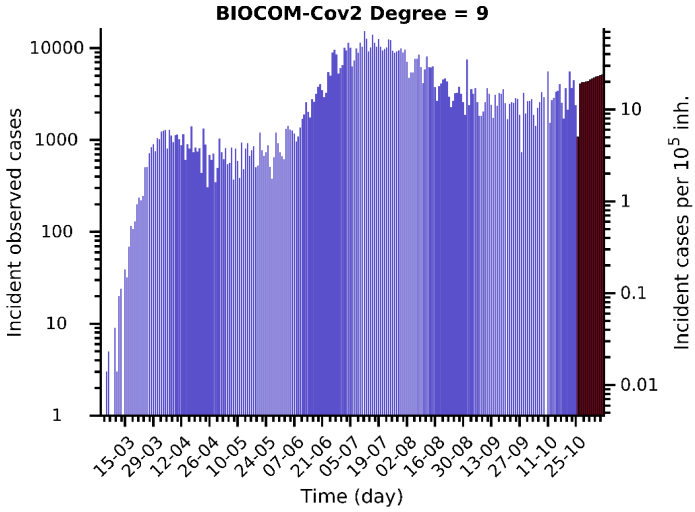
Predictions for next days

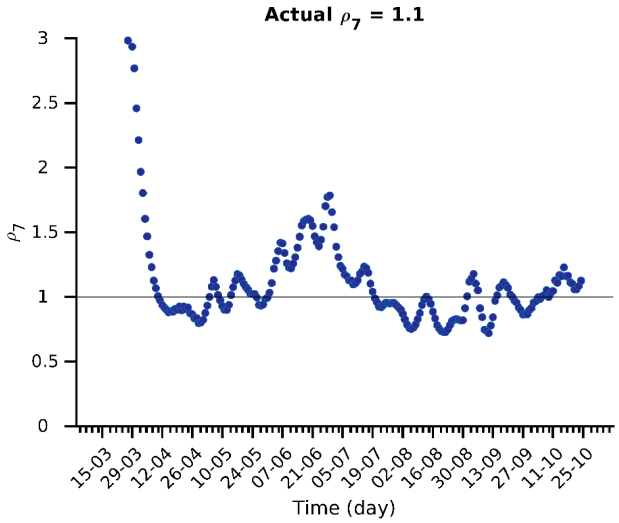
Day	Number of cases
26-10-2020	779705 (+1077)
28-10-2020	788013 (+4251)
30-10-2020	796579 (+4312)

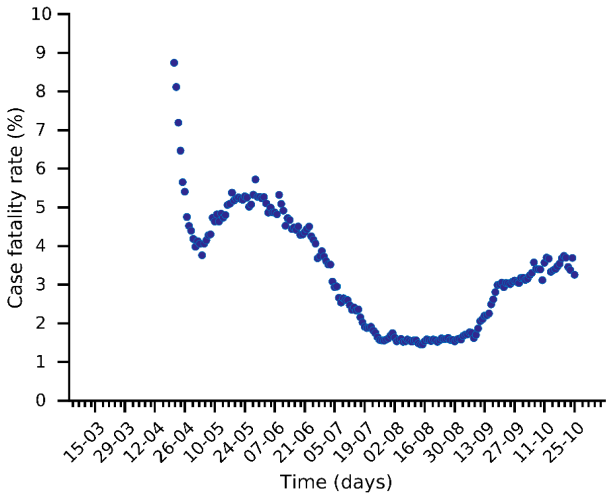
Current indicators

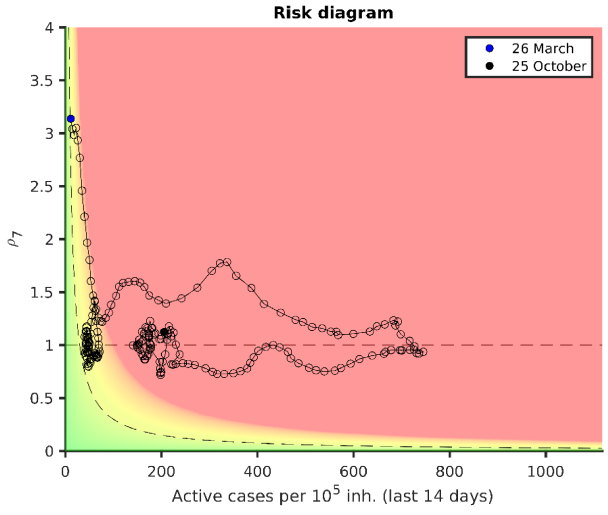
A_{14}	EPG	CFR
206	231	3.26 %

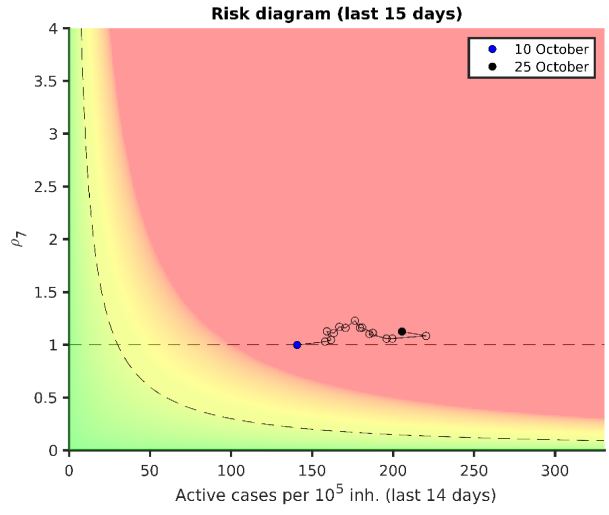




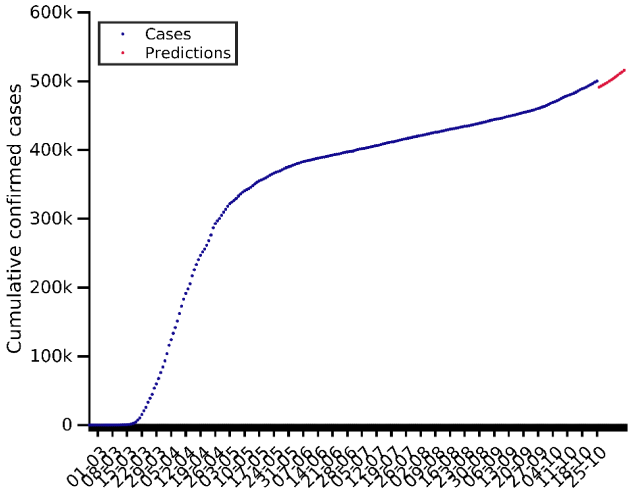








New York 25-10-2020. Pop: 19.5M. Cumulative incidence: 2571/10⁵

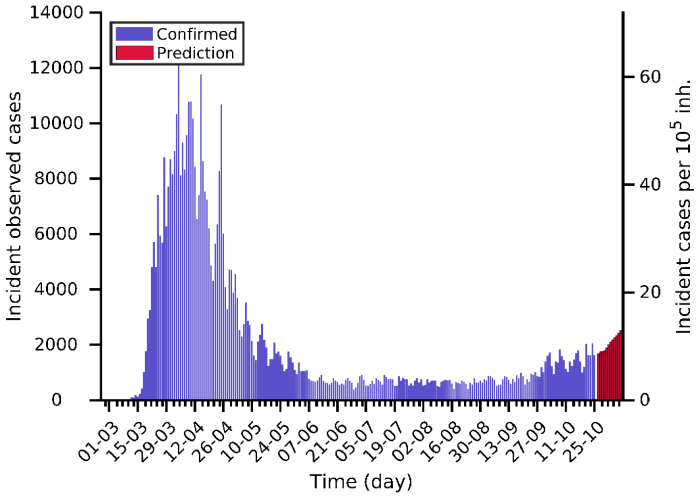


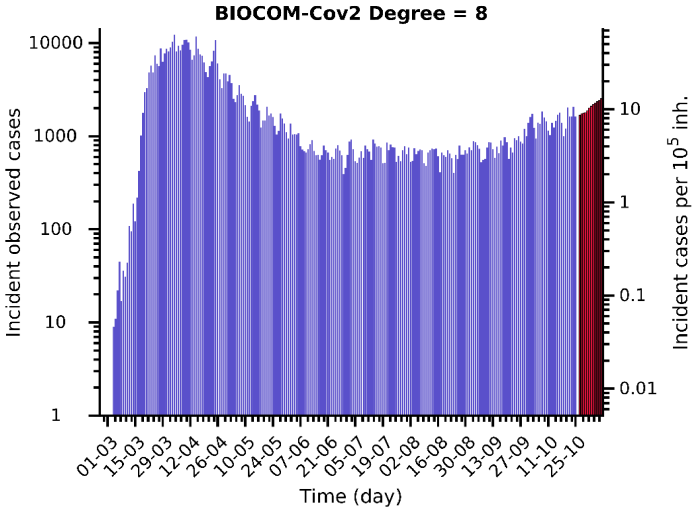
Predictions for next days

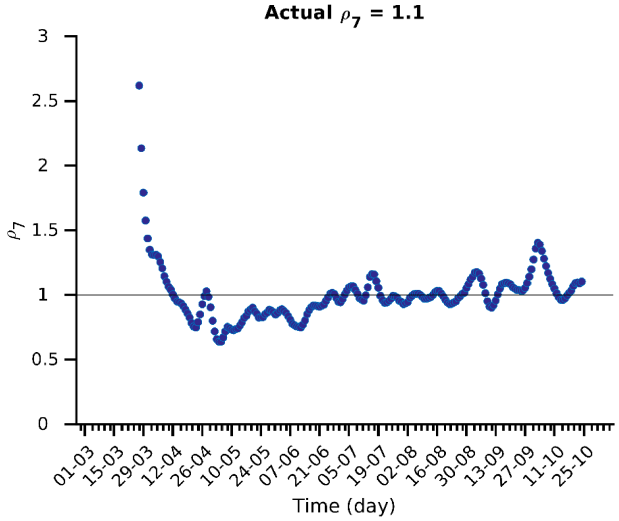
Day	Number of cases
26-10-2020	491291 (+-8910)
28-10-2020	494714 (+1749)
30-10-2020	498273 (+1792)

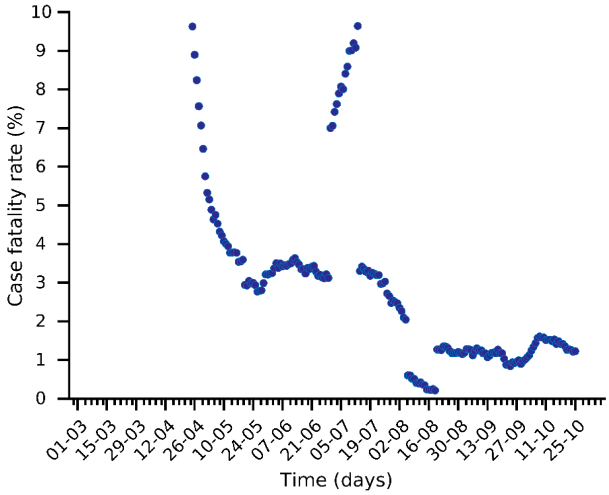
Current indicators

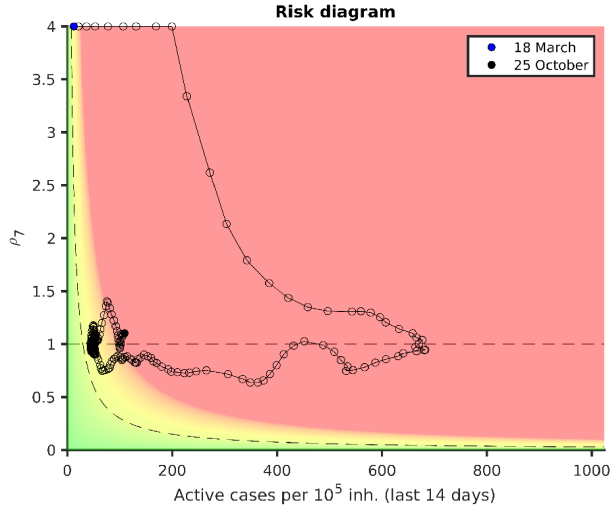
A_{14}	EPG	CFR
109	120	1.22 %

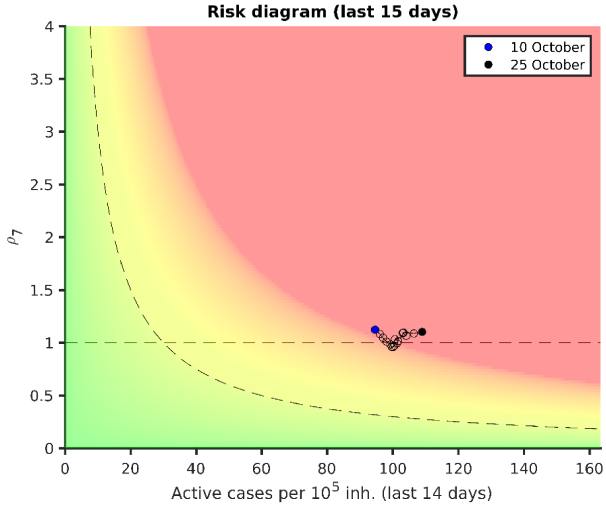




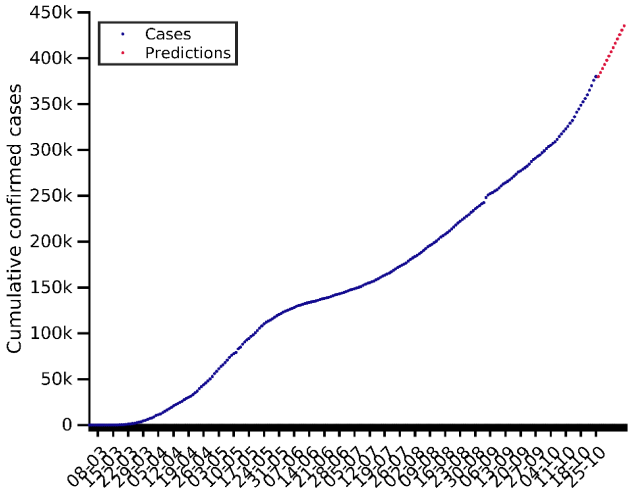








Illinois 25-10-2020. Pop: 12.7M. Cumulative incidence: 2999/10^5

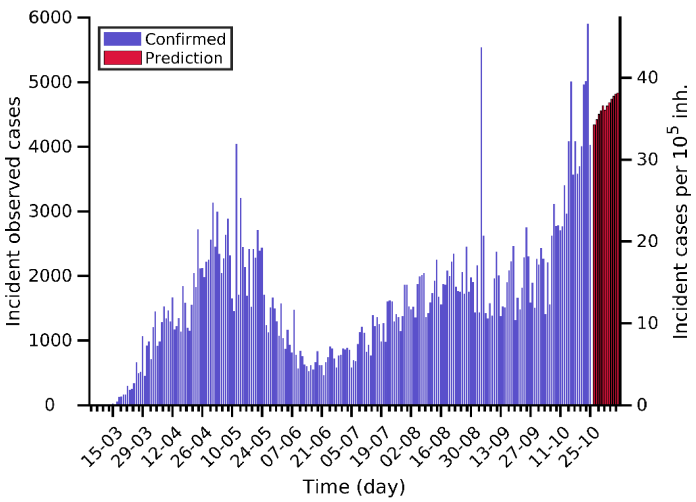


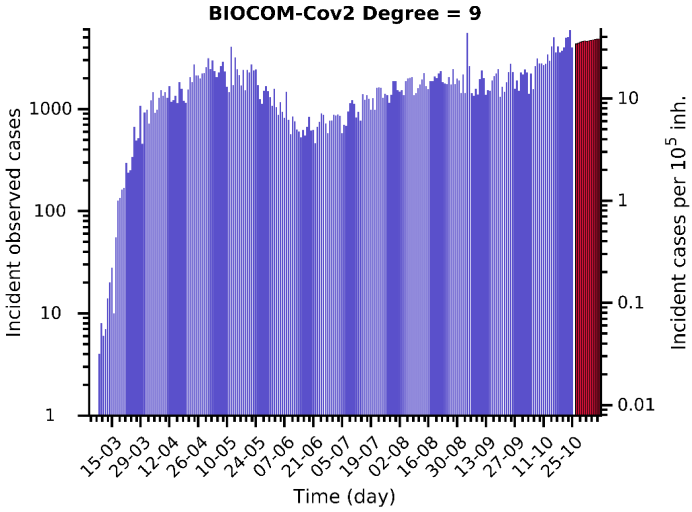
Predictions for next days

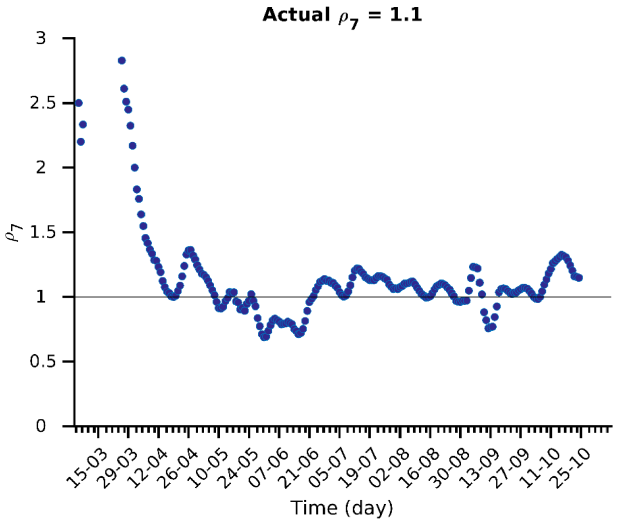
Day	Number of cases
26-10-2020	380010 (+-55)
28-10-2020	388772 (+4421)
30-10-2020	397832 (+4560)

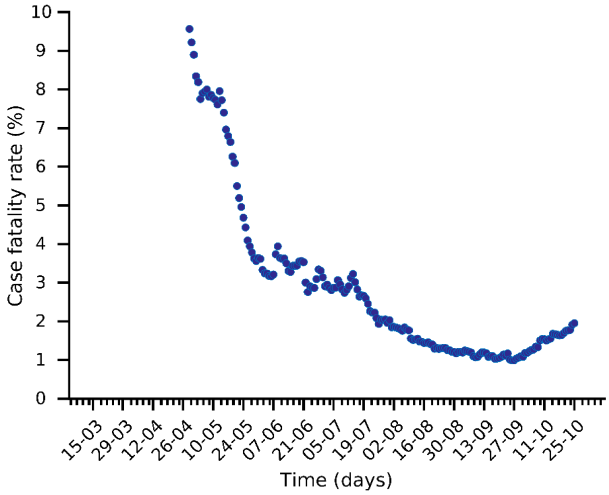
Current indicators

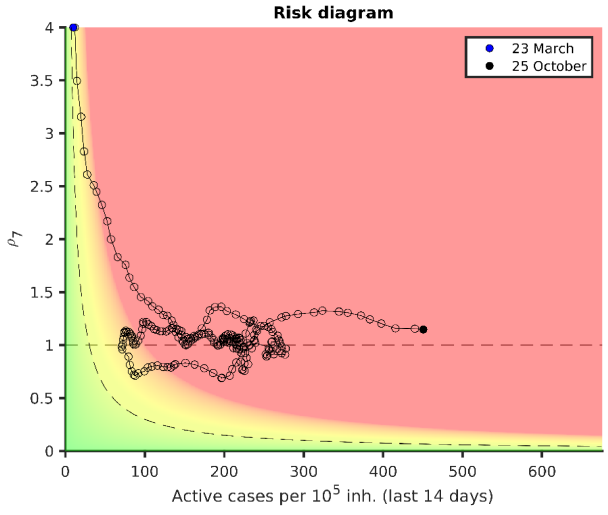
A_{14}	EPG	CFR
450	517	1.95 %

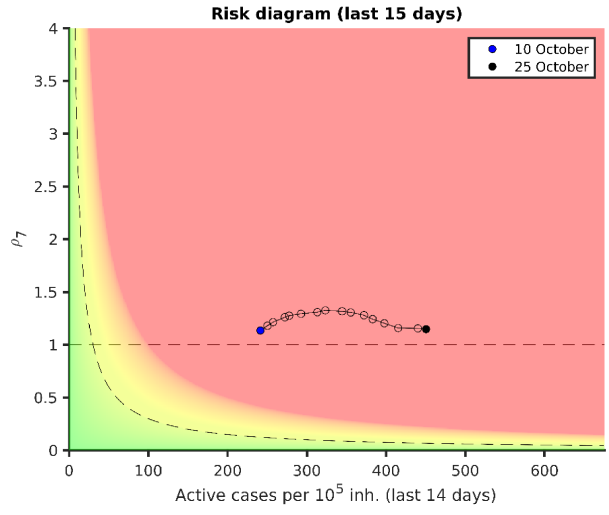




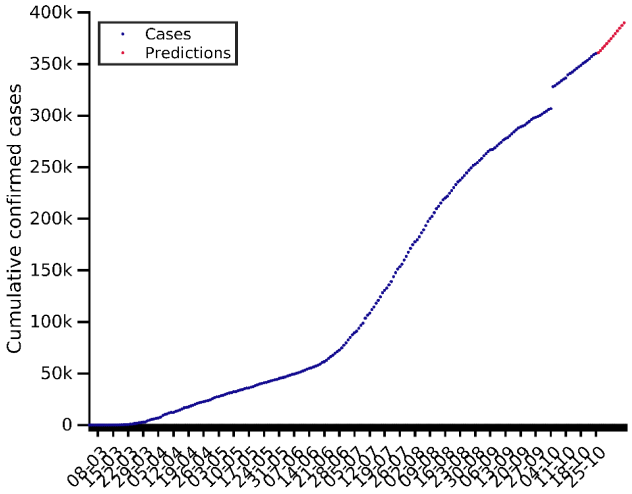








Georgia 25-10-2020. Pop: 10.6M. Cumulative incidence: 3394/10⁵

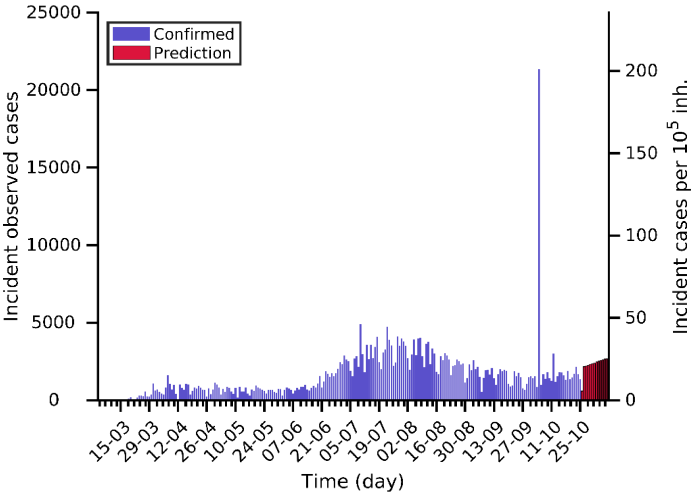


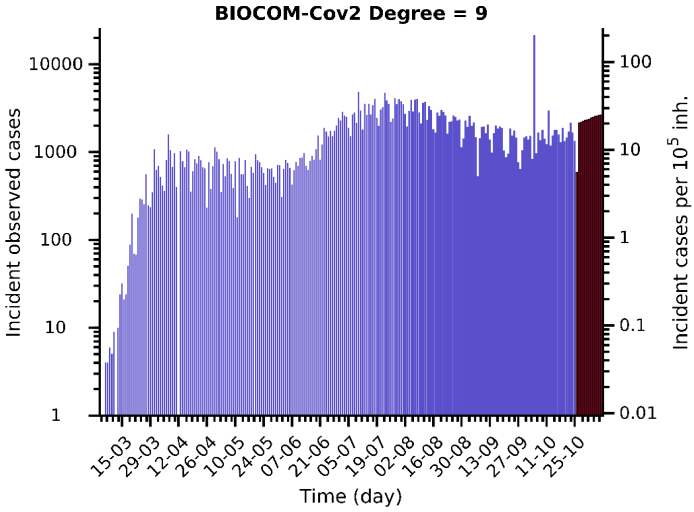
Predictions for next days

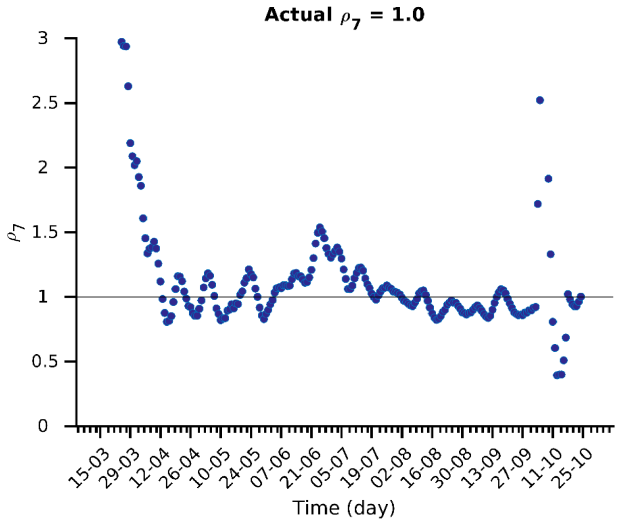
Day	Number of cases
26-10-2020	360935 (+591)
28-10-2020	365294 (+2200)
30-10-2020	369853 (+2316)

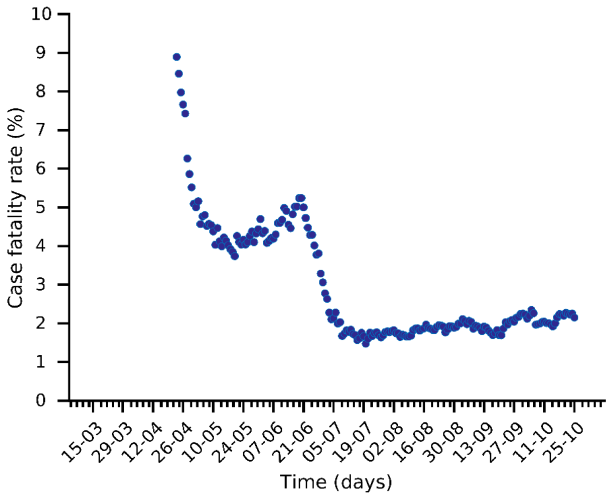
Current indicators

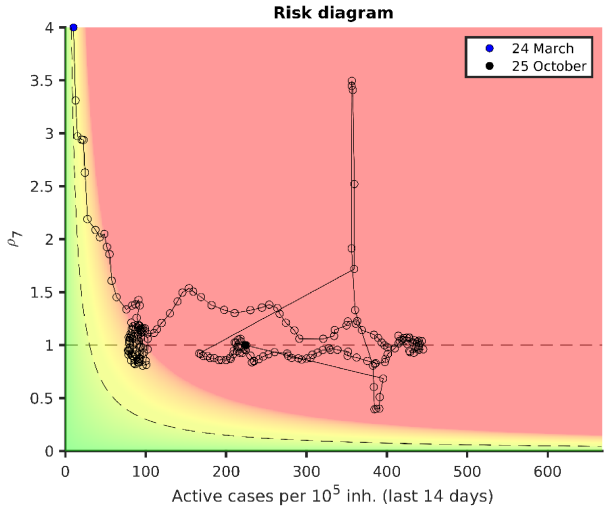
A_{14}	EPG	CFR
224	224	2.15 %

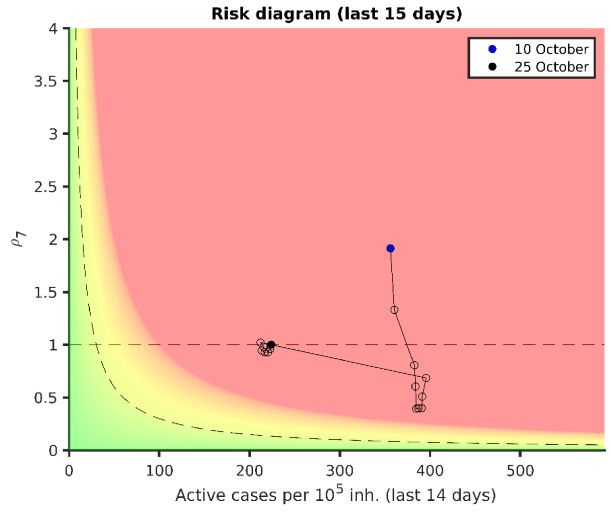




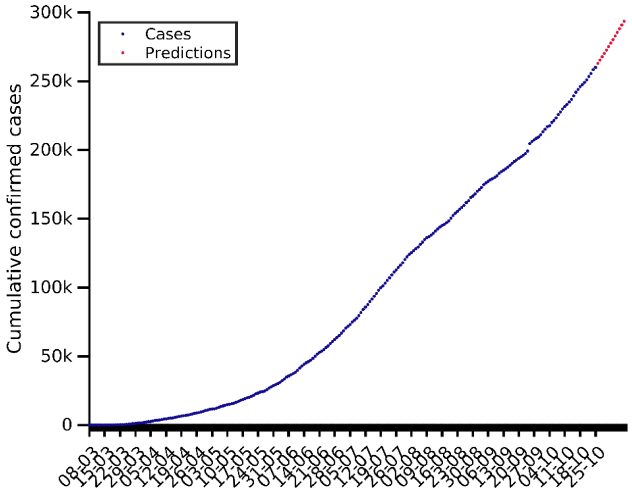








North Carolina 25-10-2020. Pop: 10.5M. Cumulative incidence: 2480/10^5

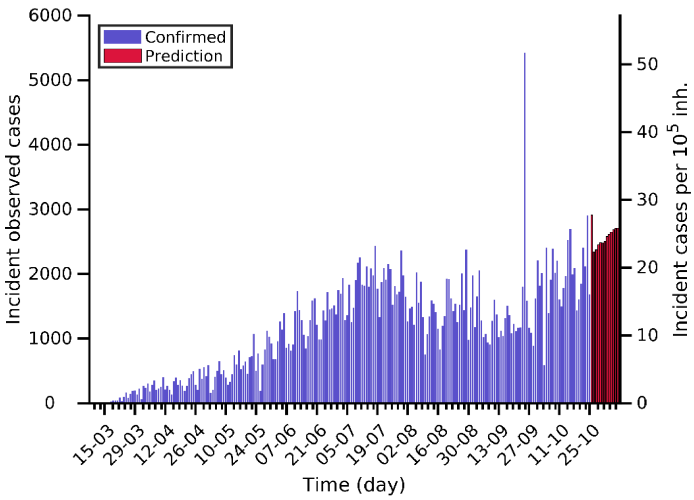


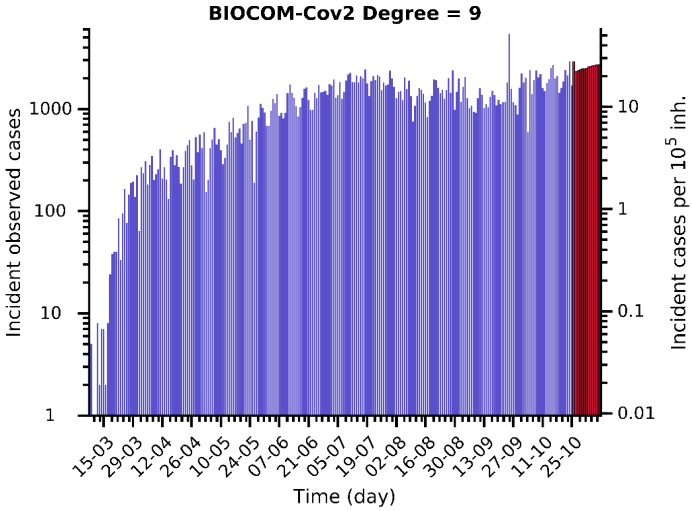
Predictions for next days

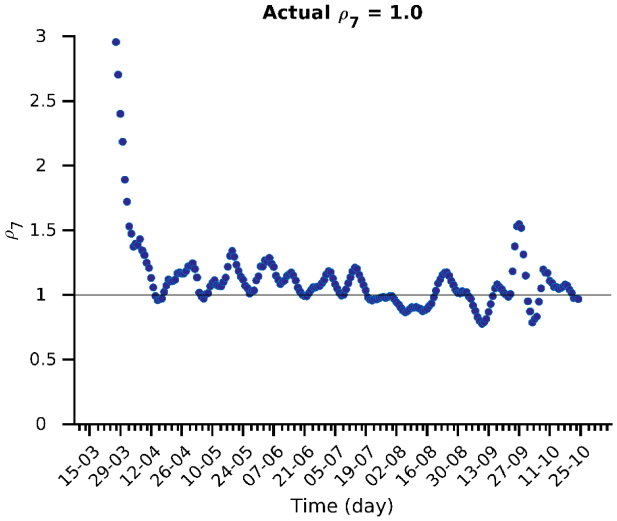
Day	Number of cases
26-10-2020	263038 (+2910)
28-10-2020	267758 (+2377)
30-10-2020	272695 (+2485)

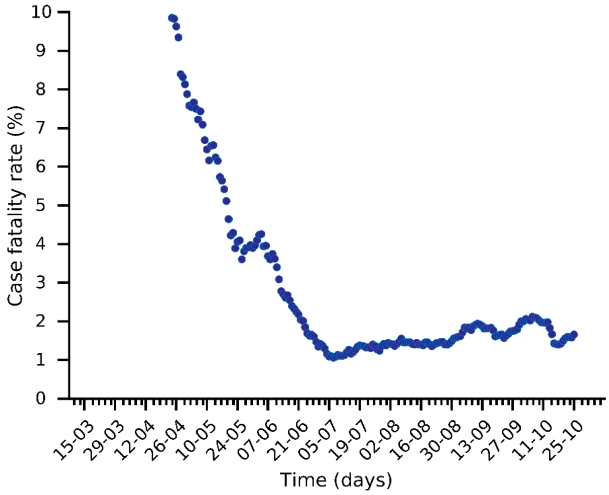
Current indicators

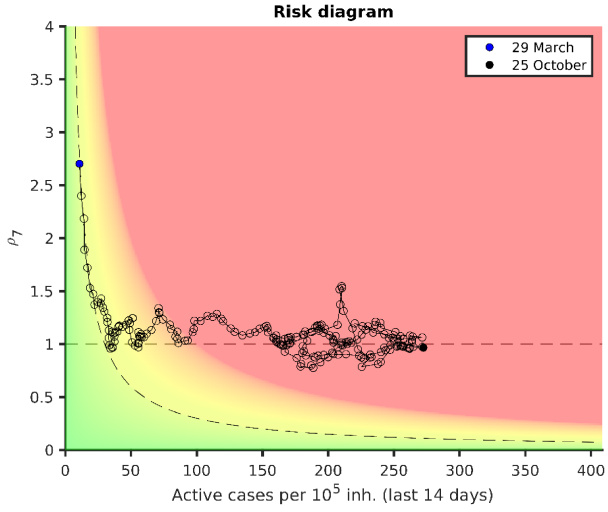
A_{14}	EPG	CFR
272	263	1.66 %

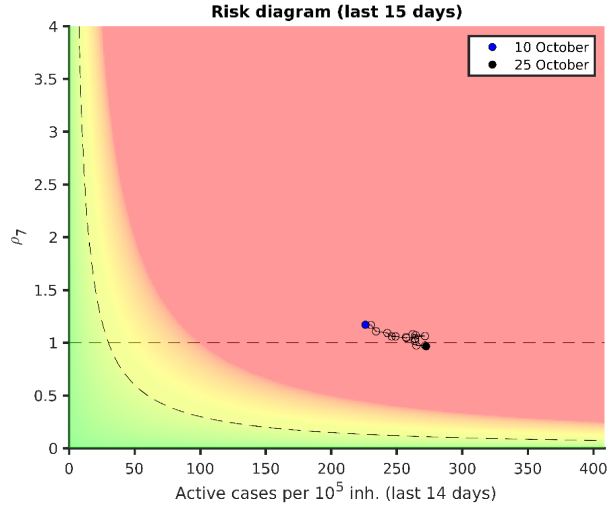




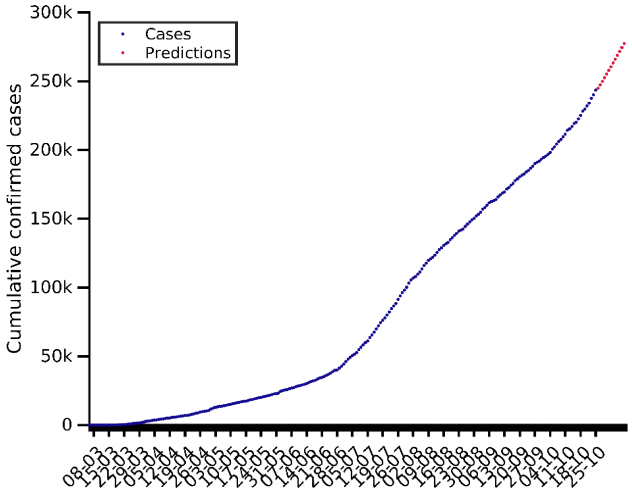








Tennessee 25-10-2020. Pop: 6.8M. Cumulative incidence: 3566/10⁵

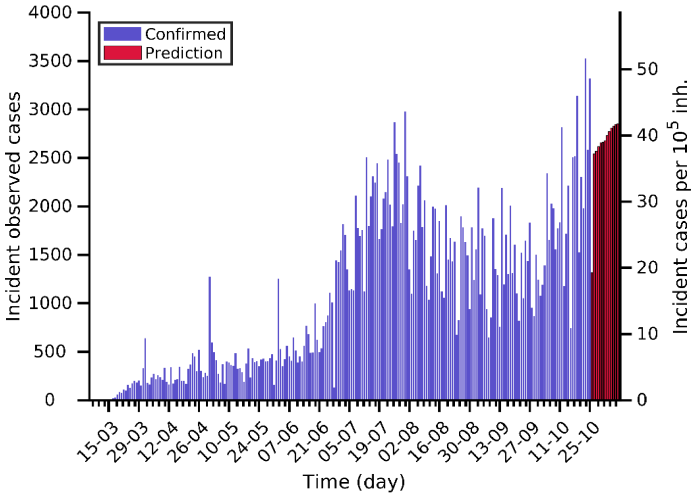


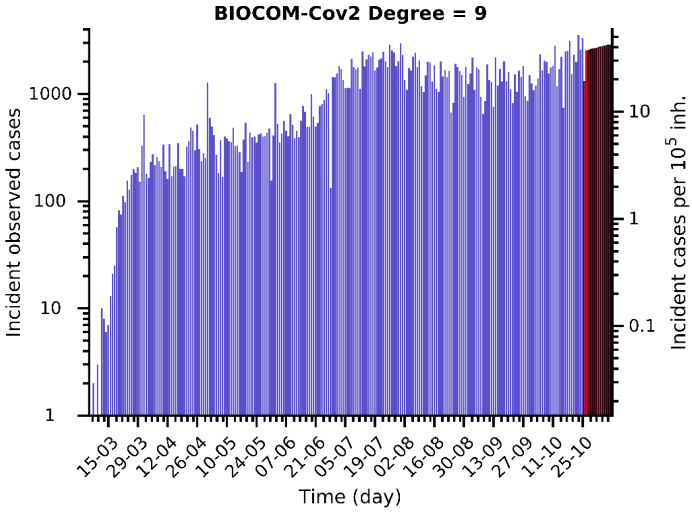
Predictions for next days

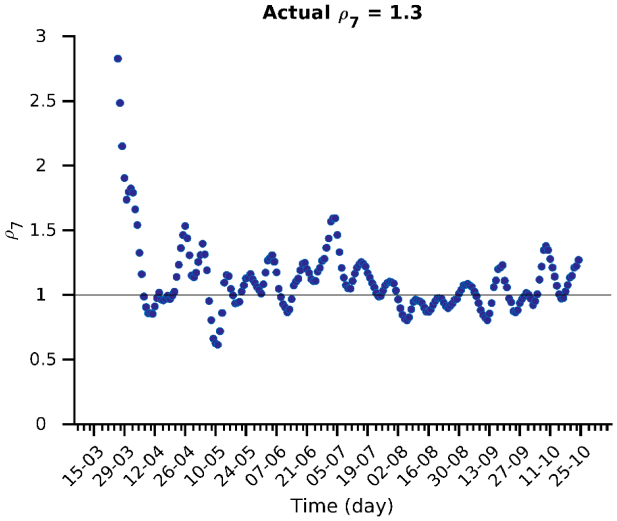
Day	Number of cases
26-10-2020	244823 (+1315)
28-10-2020	249934 (+2569)
30-10-2020	255208 (+2656)

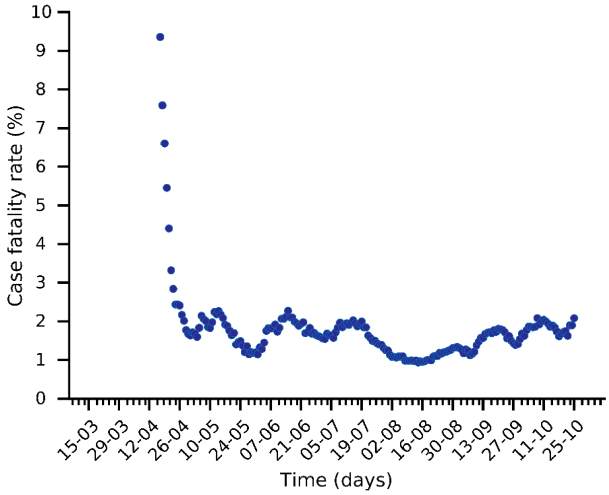
Current indicators

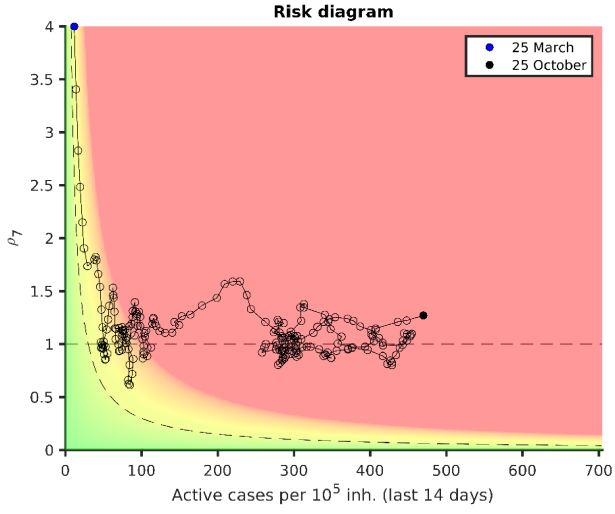
A_{14}	EPG	CFR
470	597	2.08 %

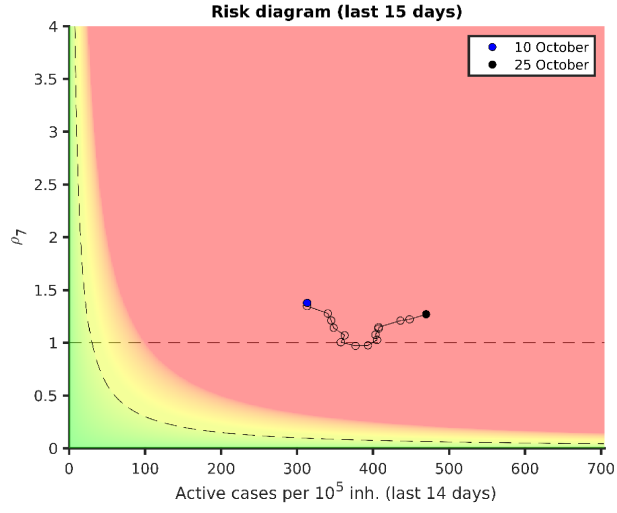




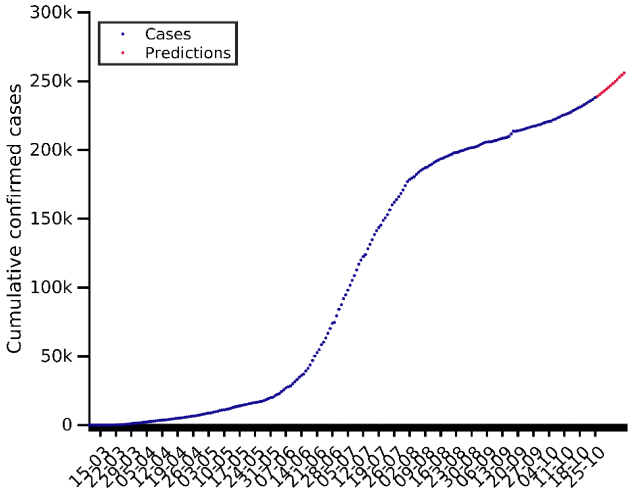








Arizona 25-10-2020. Pop: 7.3M. Cumulative incidence: 3273/10⁵

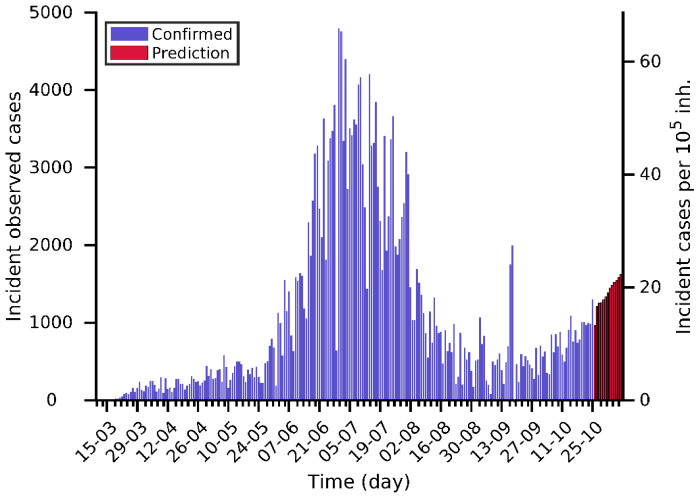


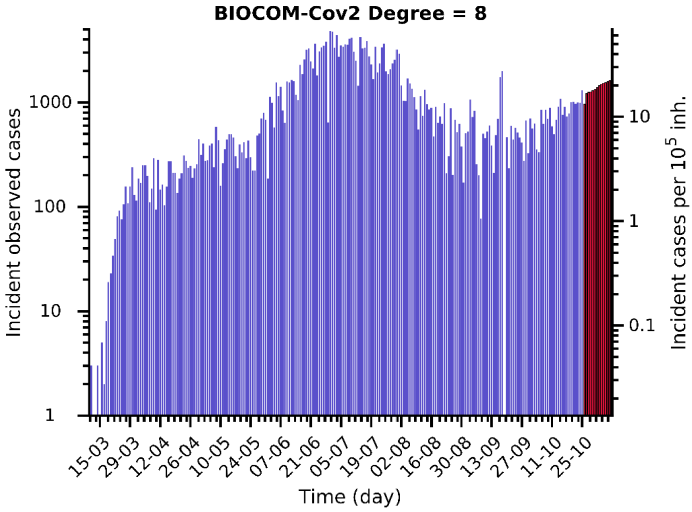
Predictions for next days

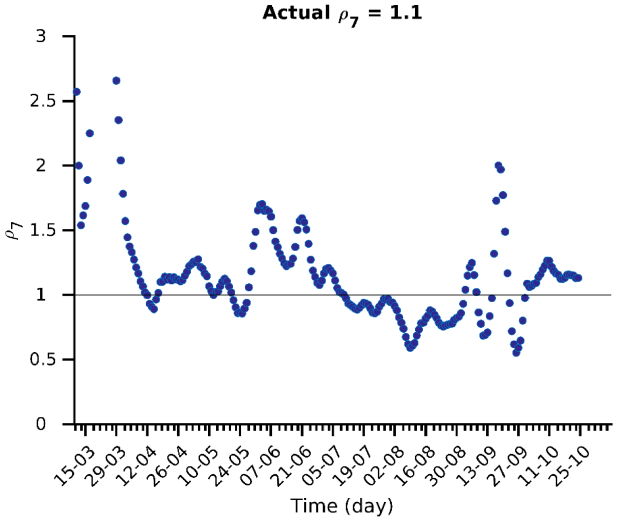
Day	Number of cases
26-10-2020	239160 (+960)
28-10-2020	241624 (+1253)
30-10-2020	244176 (+1295)

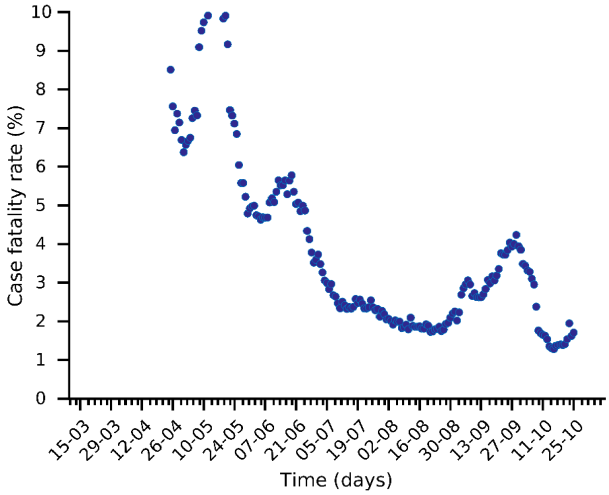
Current indicators

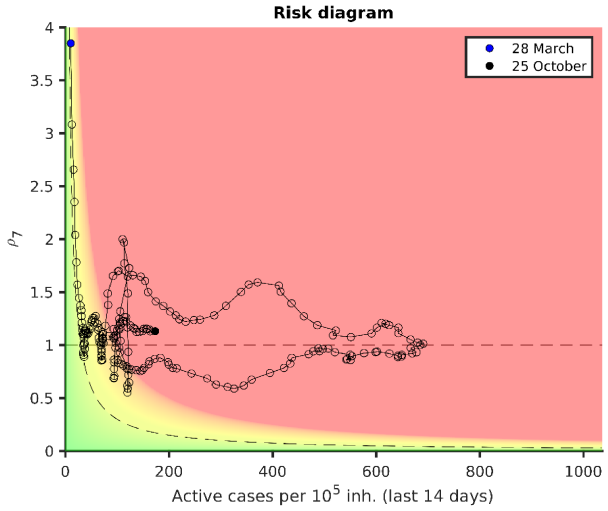
A_{14}	EPG	CFR
173	196	1.71 %

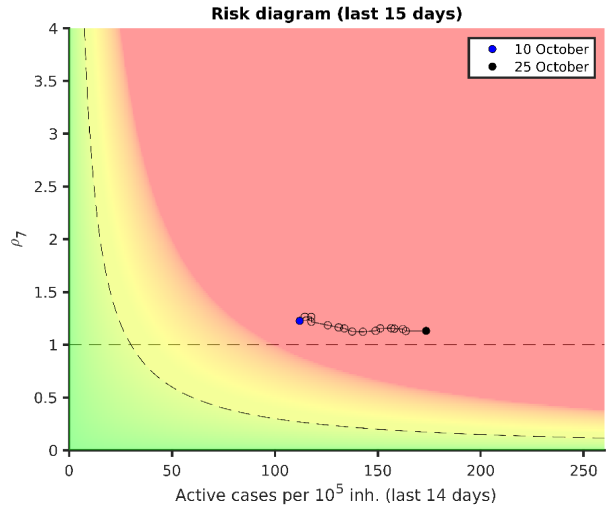




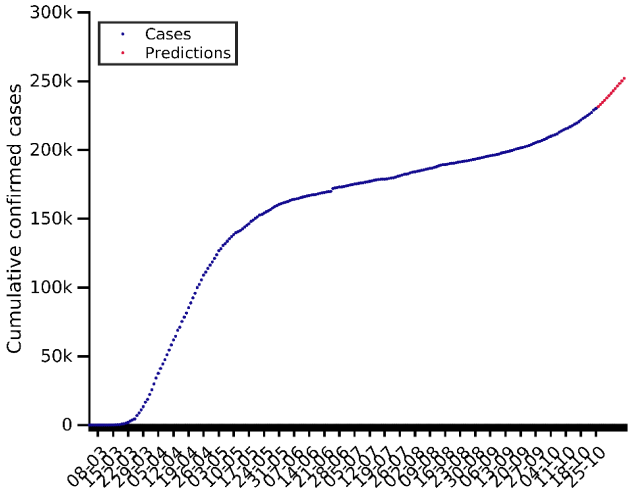








New Jersey 25-10-2020. Pop: 8.9M. Cumulative incidence: 2592/10^5

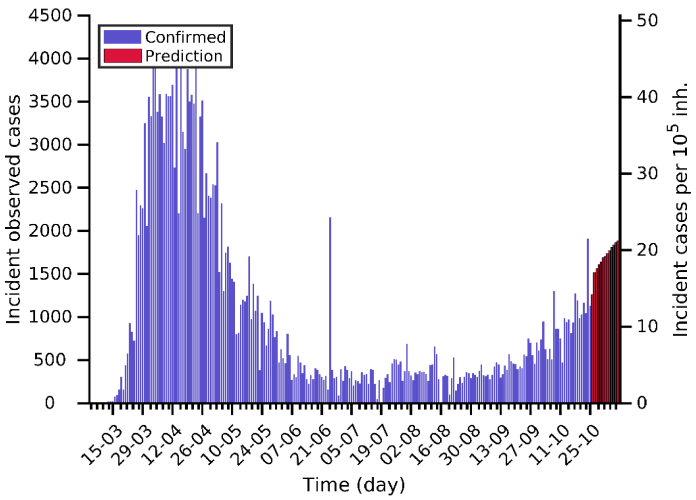


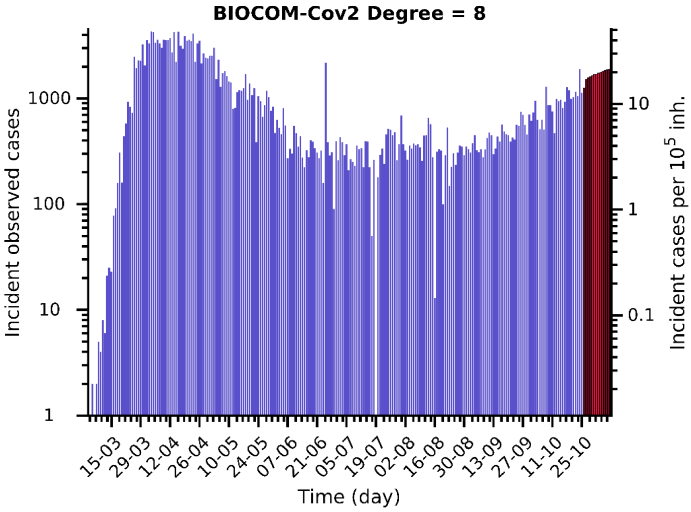
Predictions for next days

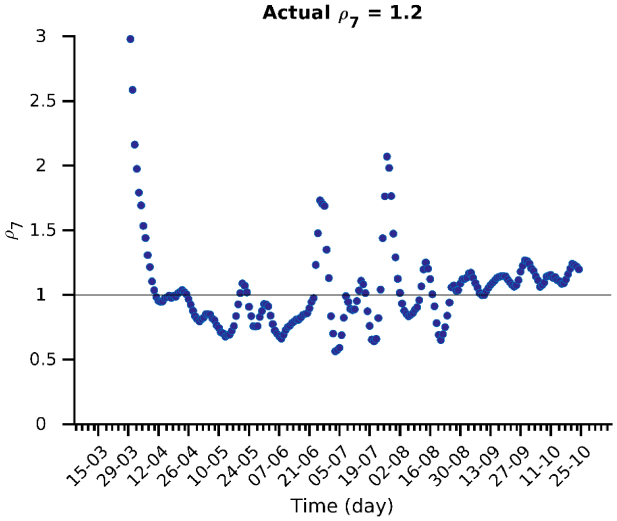
Day	Number of cases
26-10-2020	231518 (+1261)
28-10-2020	234593 (+1562)
30-10-2020	237835 (+1635)

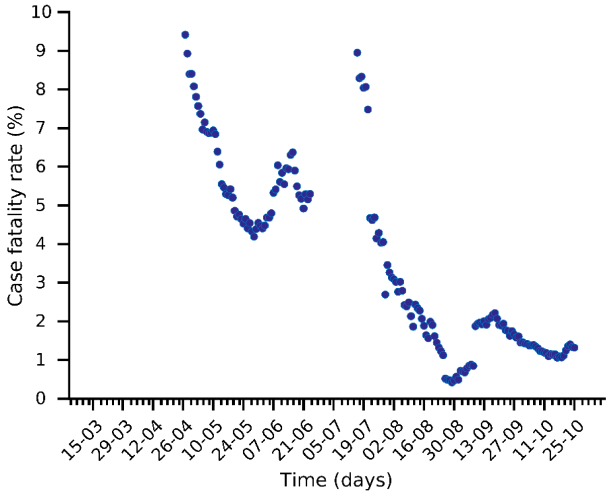
Current indicators

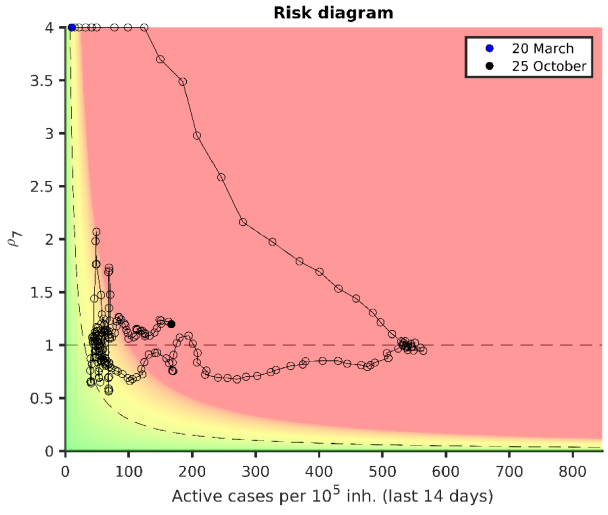
A_{14}	EPG	CFR
167	200	1.32 %

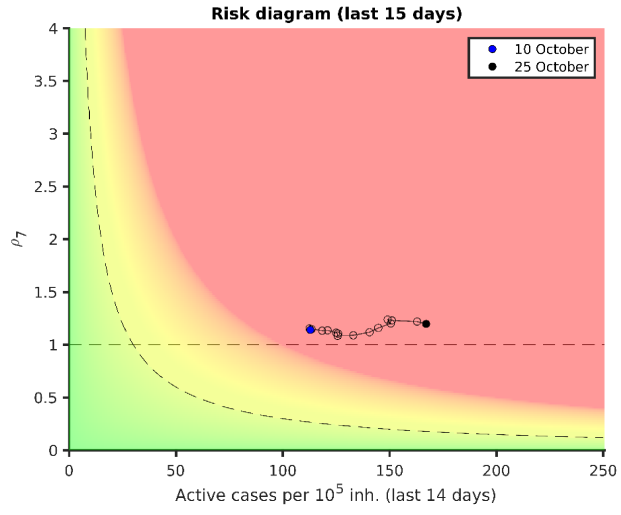




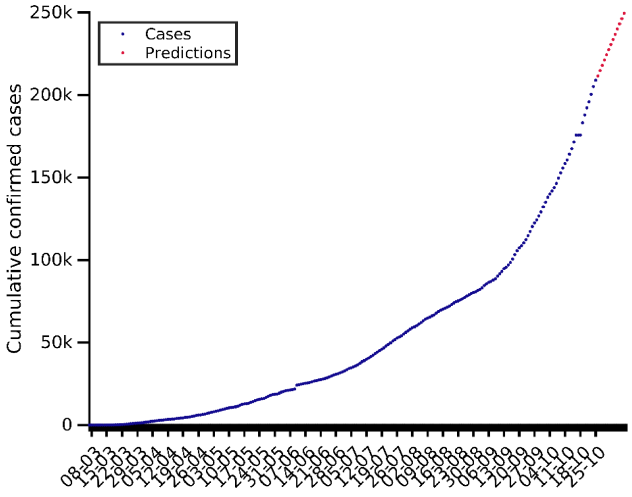








Wisconsin 25-10-2020. Pop: 5.8M. Cumulative incidence: 3588/10^5

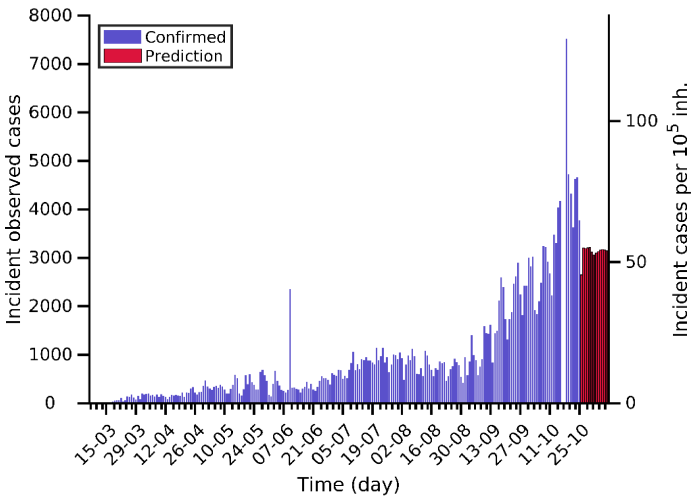


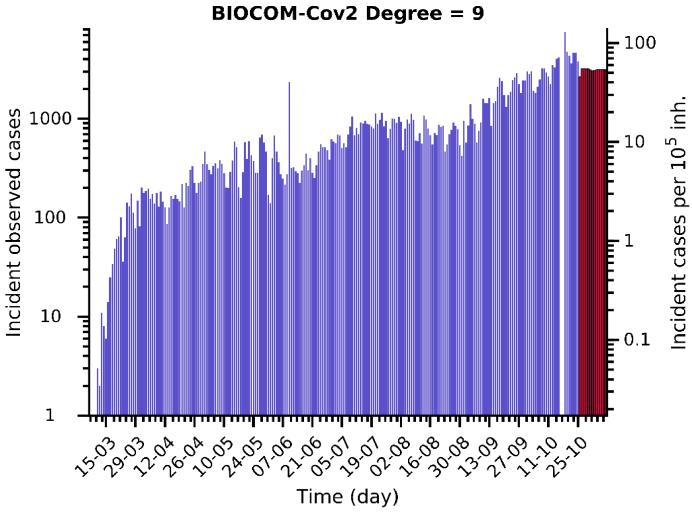
Predictions for next days

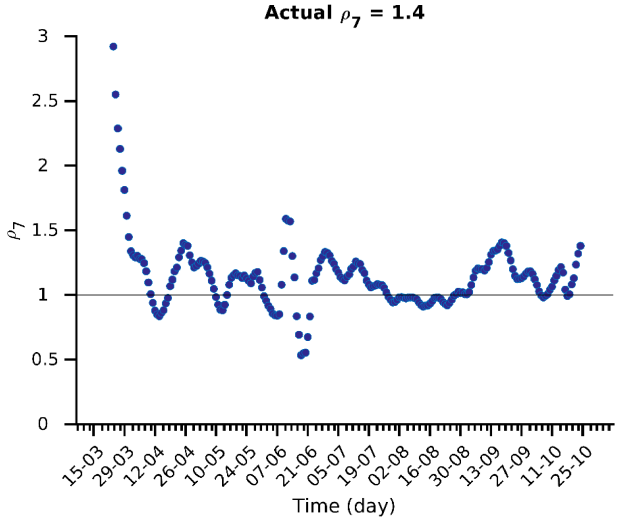
Day	Number of cases
26-10-2020	211562 (+2645)
28-10-2020	217961 (+3192)
30-10-2020	224388 (+3218)

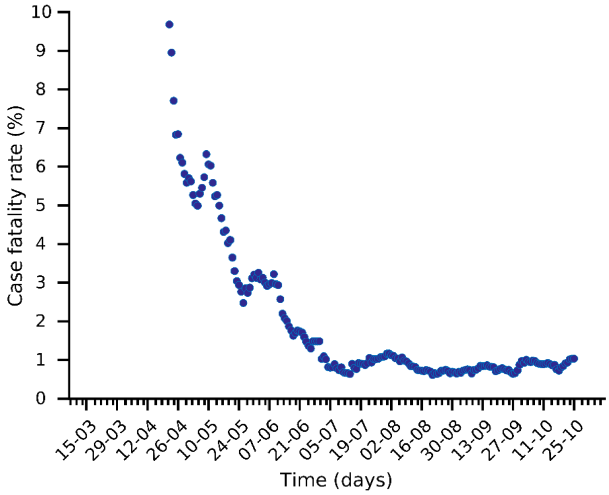
Current indicators

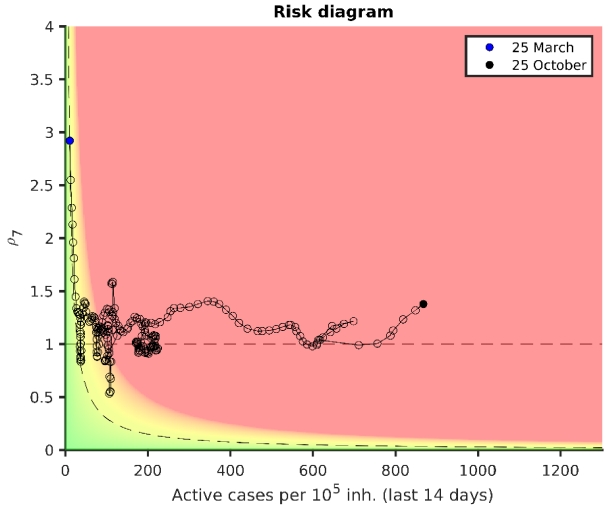
A_{14}	EPG	CFR
867	1196	1.03 %

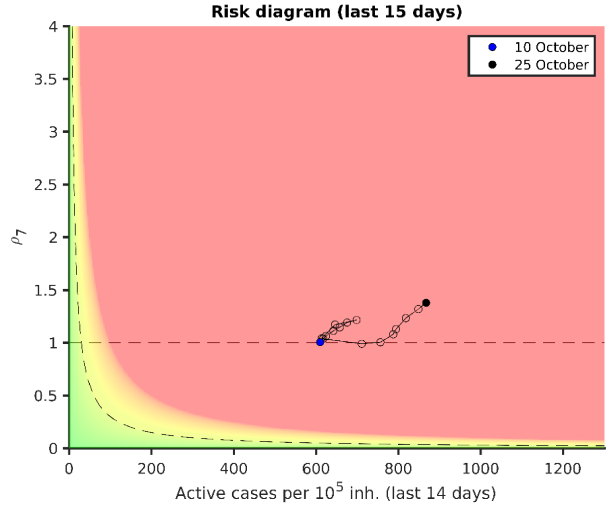




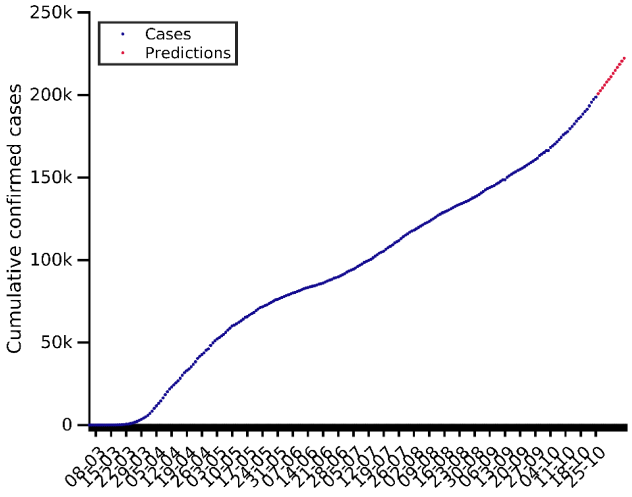








Pennsylvania 25-10-2020. Pop: 12.8M. Cumulative incidence: 1553/10^5

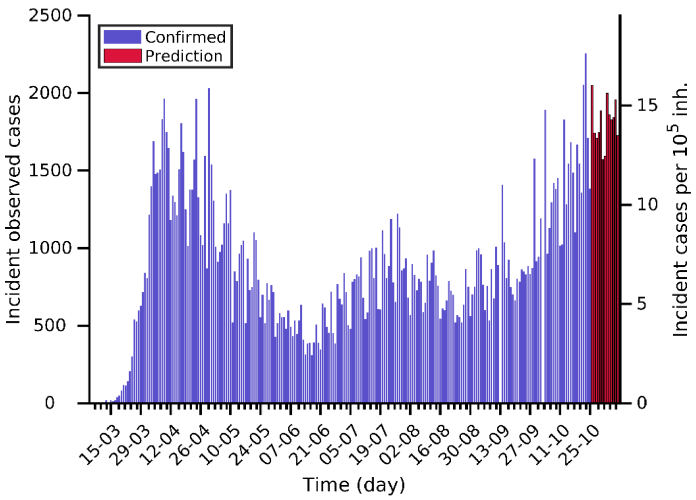


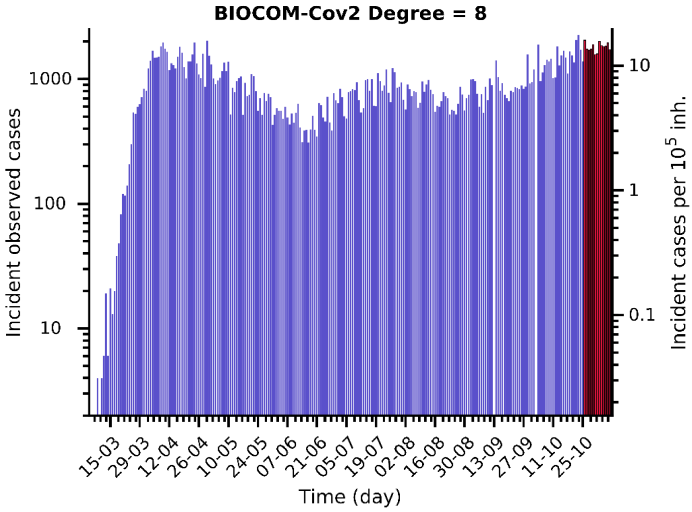
Predictions for next days

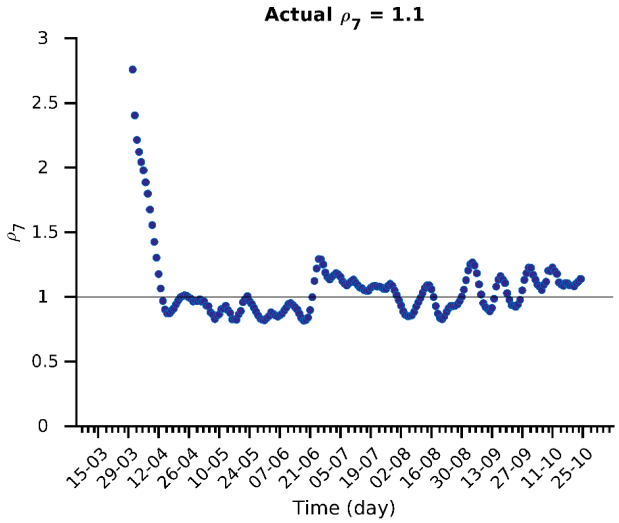
Day	Number of cases
26-10-2020	200805 (+2049)
28-10-2020	204257 (+1709)
30-10-2020	207888 (+1886)

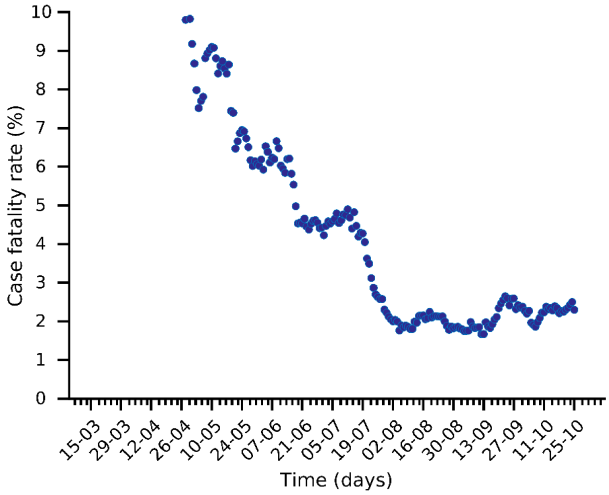
Current indicators

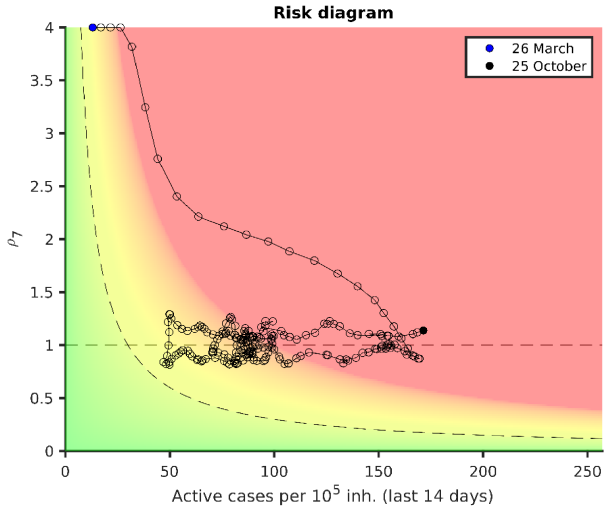
A_{14}	EPG	CFR
171	195	2.30 %

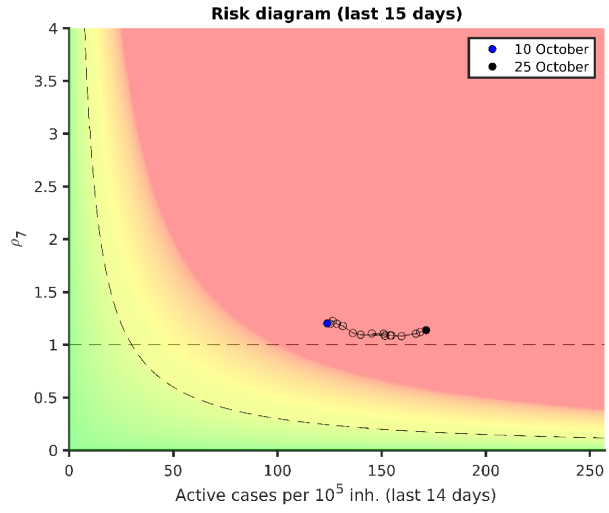




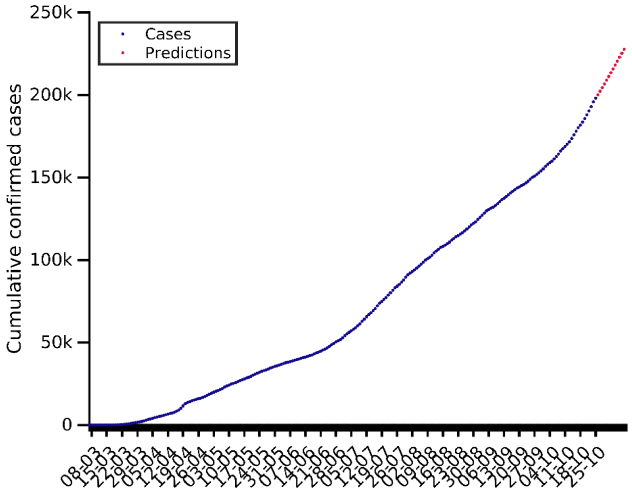








Ohio 25-10-2020. Pop: 11.7M. Cumulative incidence: 1695/10^5

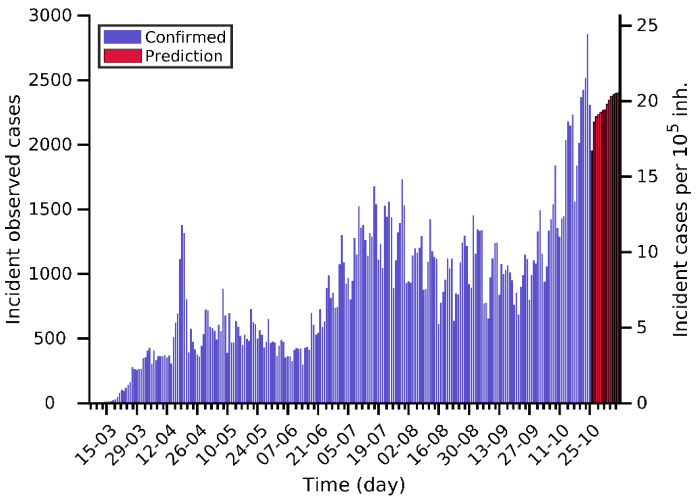


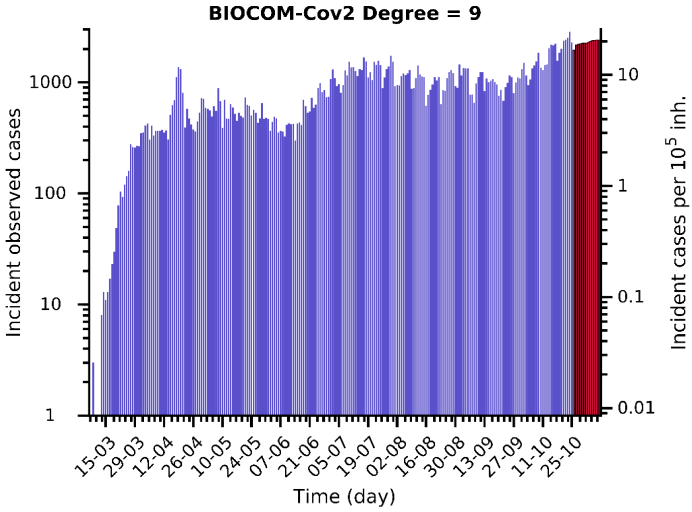
Predictions for next days

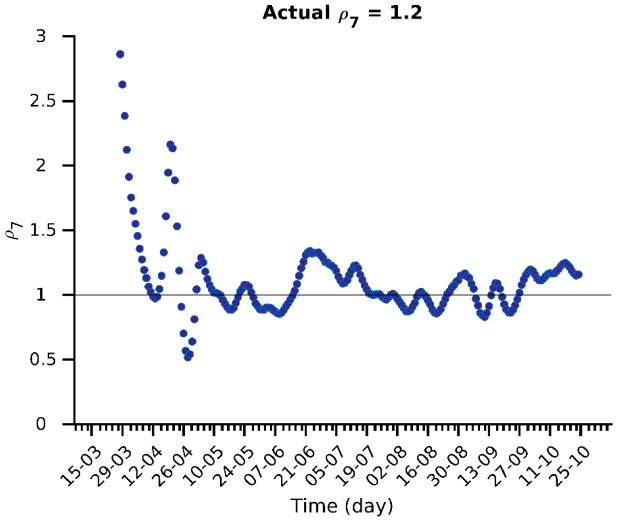
Day	Number of cases
26-10-2020	200068 (+1953)
28-10-2020	204465 (+2218)
30-10-2020	208954 (+2253)

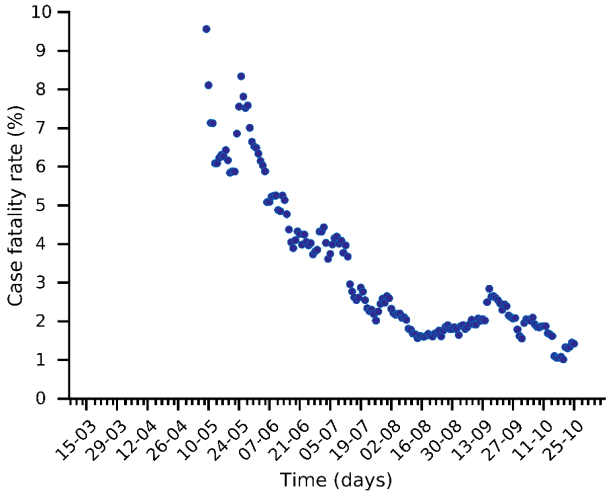
Current indicators

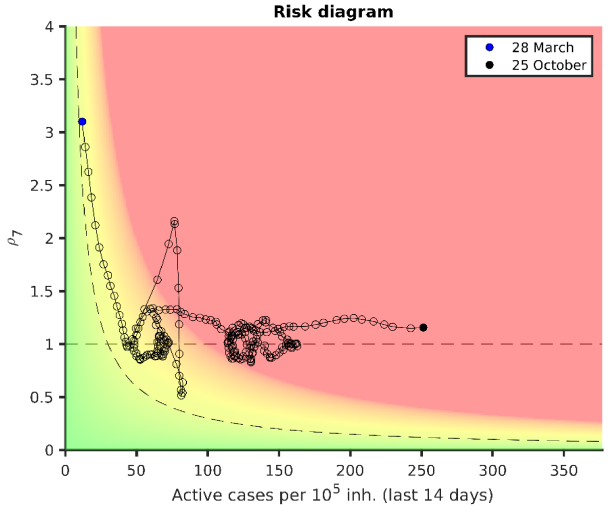
A_{14}	EPG	CFR
251	291	1.42 %

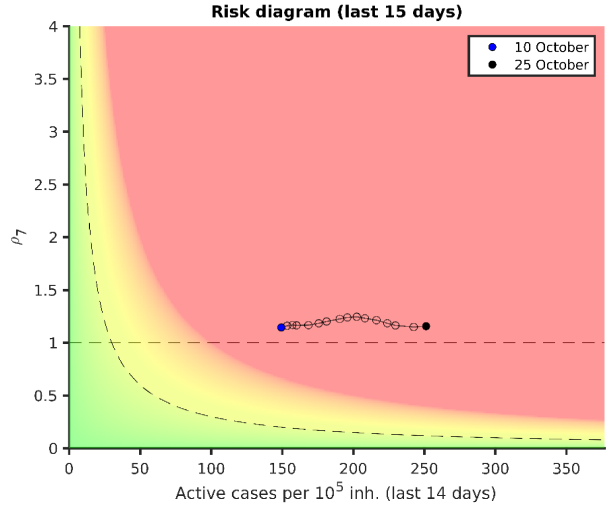




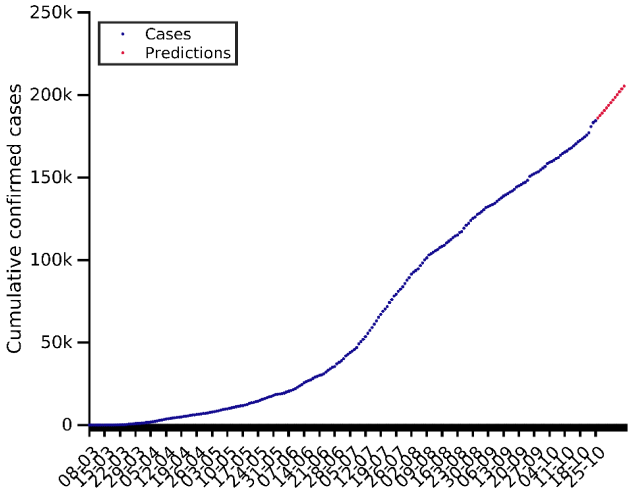








Alabama 25-10-2020. Pop: 4.9M. Cumulative incidence: 3760/10⁵

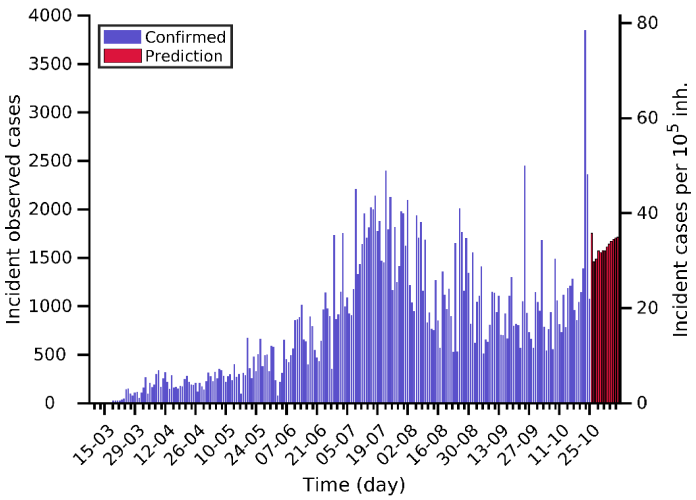


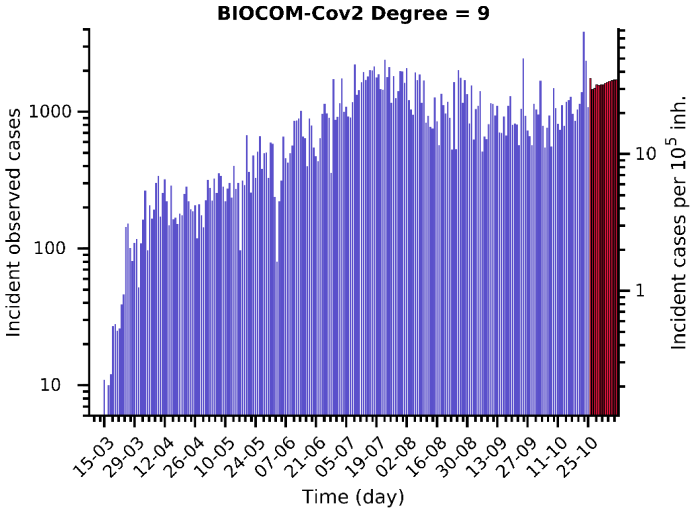
Predictions for next days

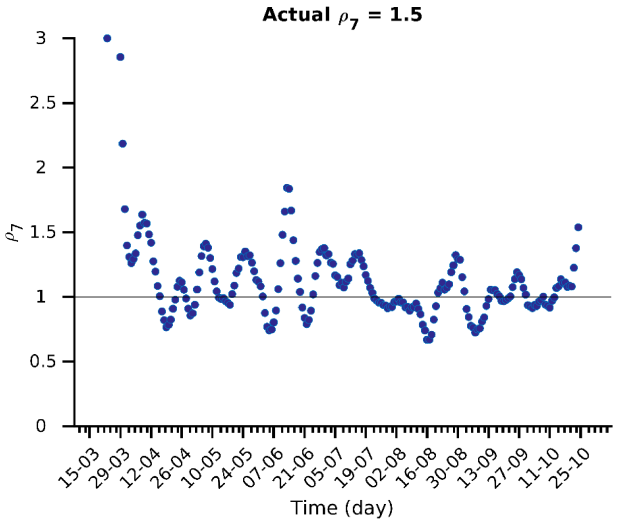
Day	Number of cases
26-10-2020	186110 (+1755)
28-10-2020	189055 (+1487)
30-10-2020	192182 (+1554)

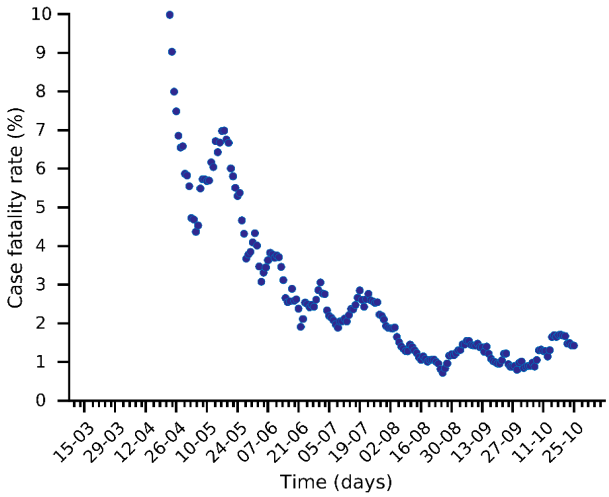
Current indicators

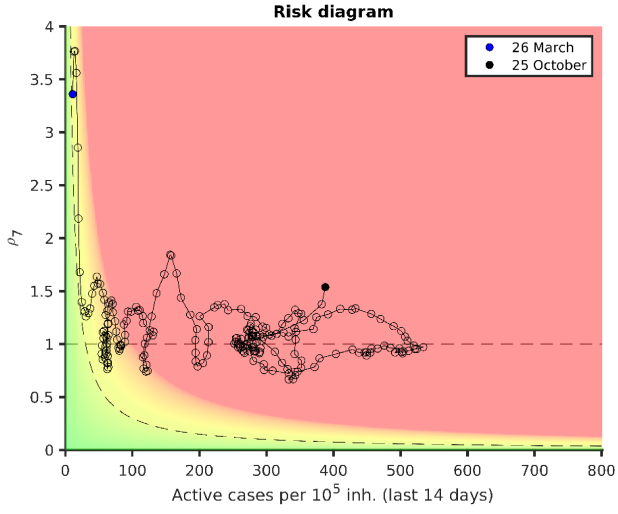
A_{14}	EPG	CFR
388	596	1.42 %

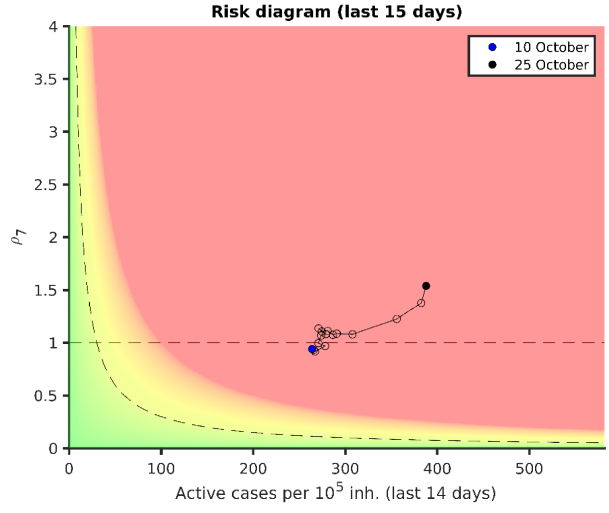




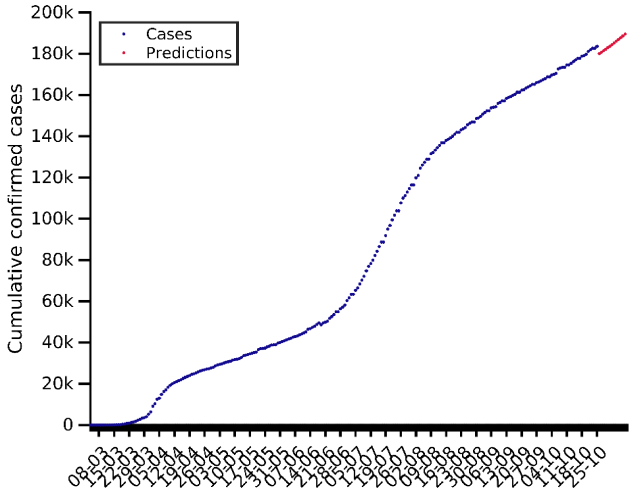








Louisiana 25-10-2020. Pop: 4.6M. Cumulative incidence: 3949/10^5

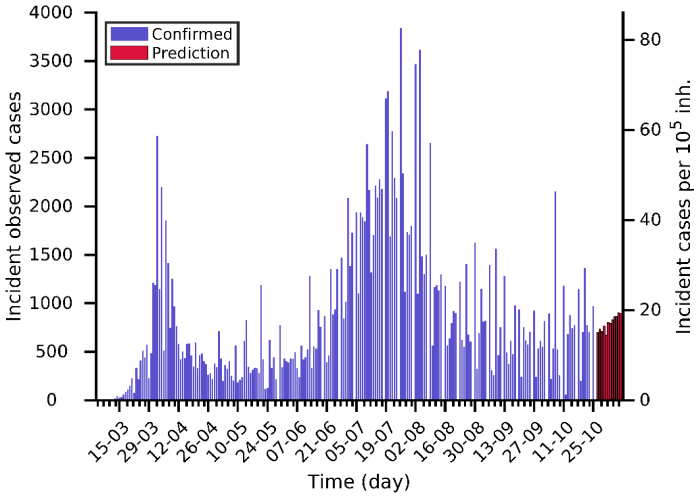


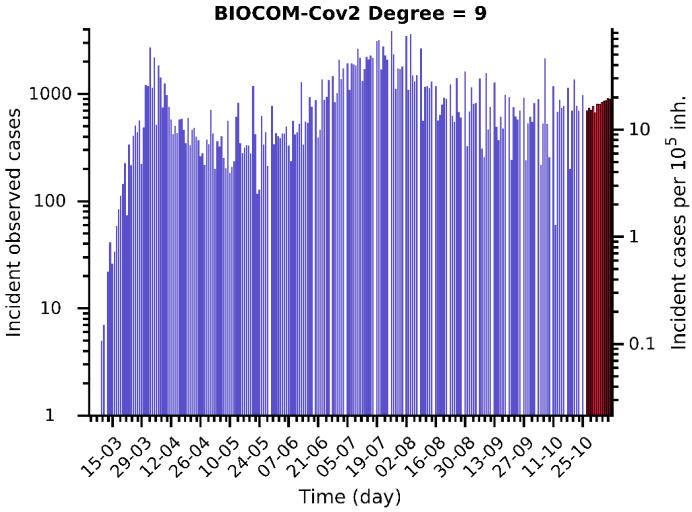
Predictions for next days

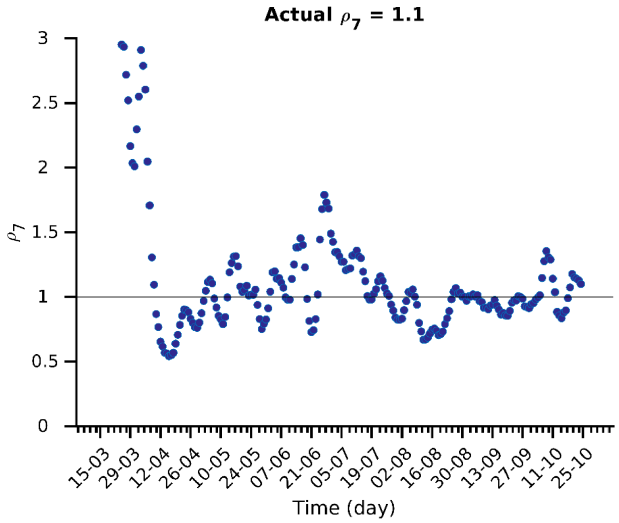
Day	Number of cases
26-10-2020	180038 (+-3537)
28-10-2020	181471 (+734)
30-10-2020	182943 (+766)

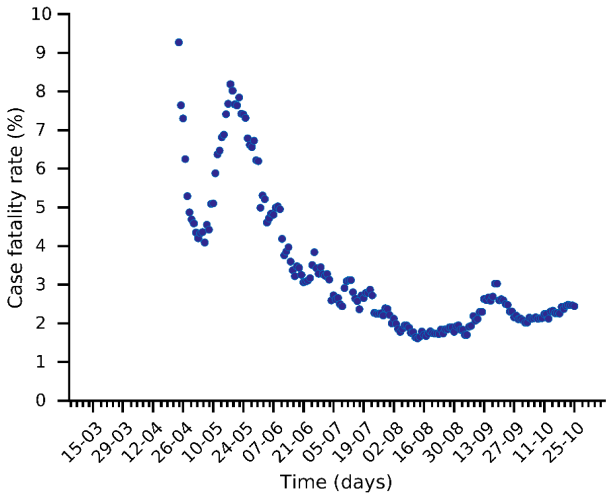
Current indicators

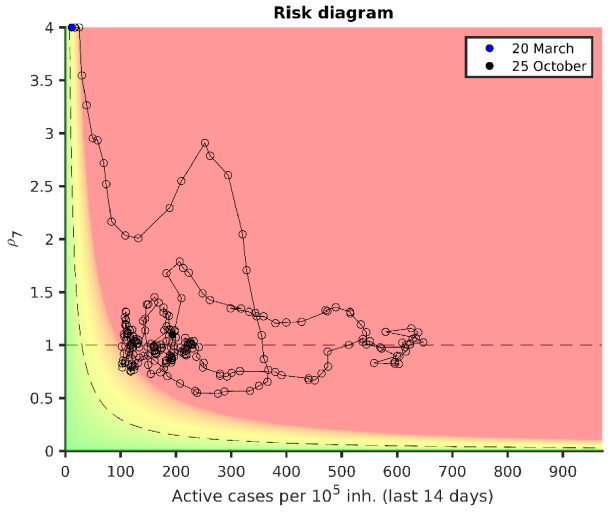
A_{14}	EPG	CFR
193	213	2.44 %

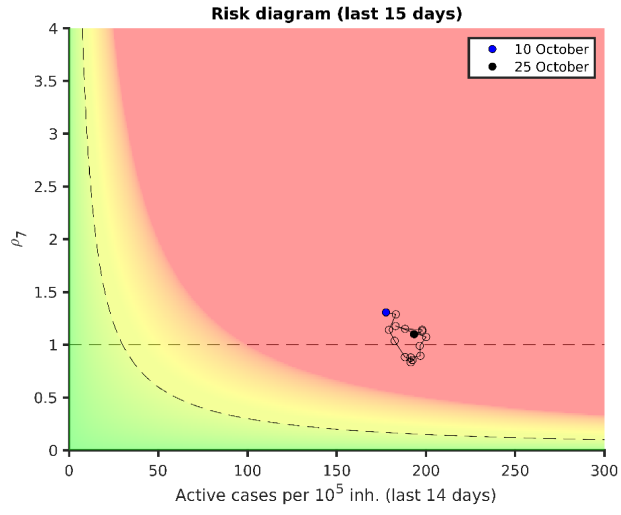




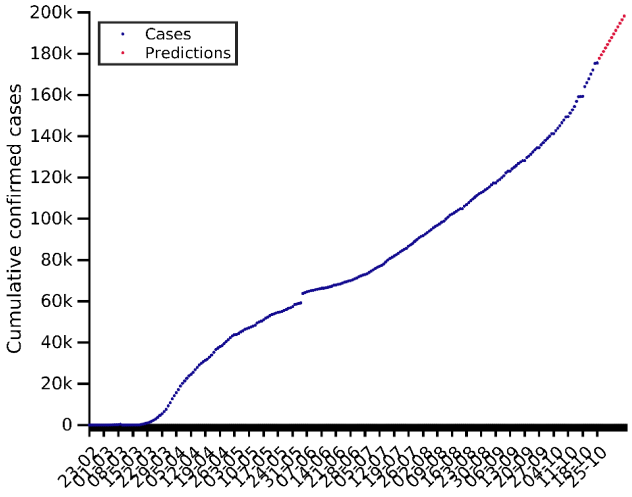








Michigan 25-10-2020. Pop: 10.0M. Cumulative incidence: 1757/10^5

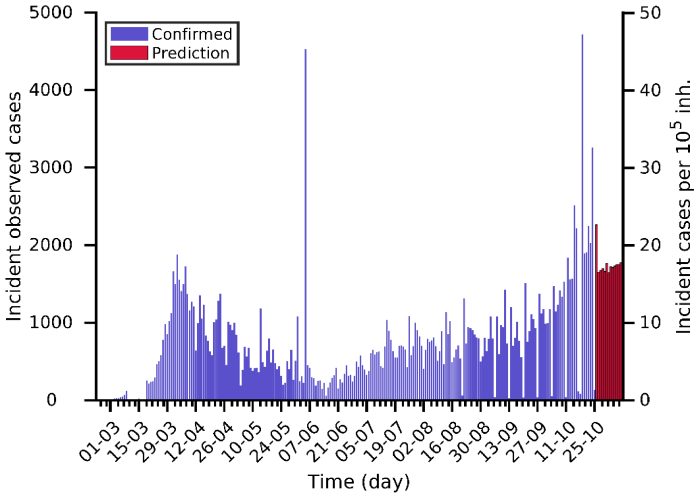


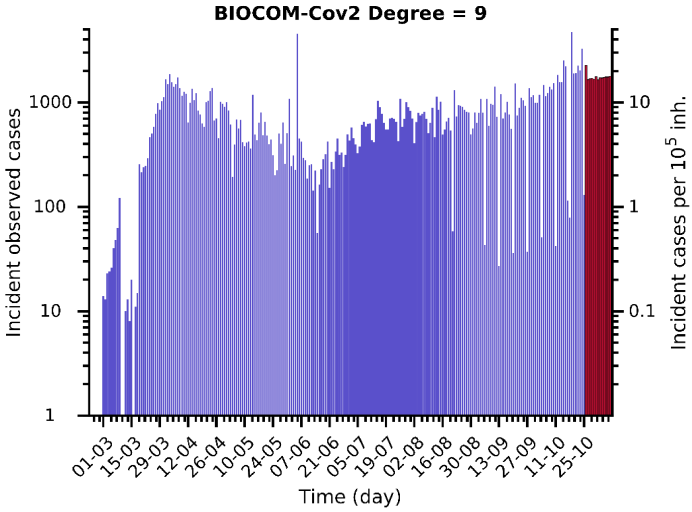
Predictions for next days

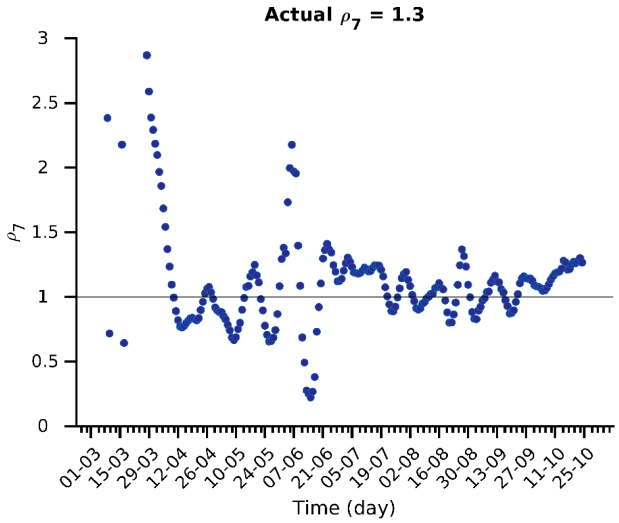
Day	Number of cases
26-10-2020	177776 (+2261)
28-10-2020	181106 (+1678)
30-10-2020	184461 (+1660)

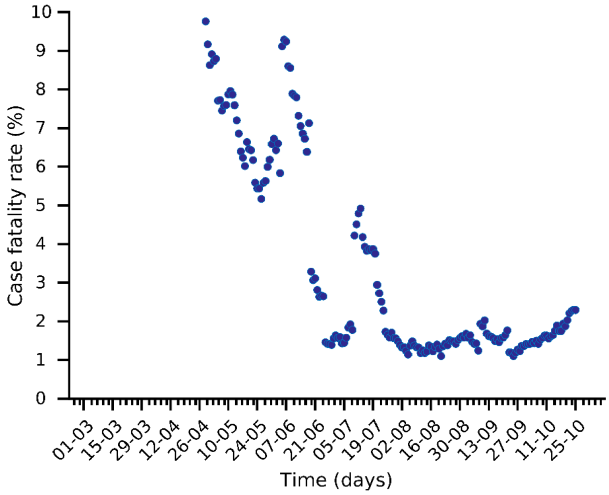
Current indicators

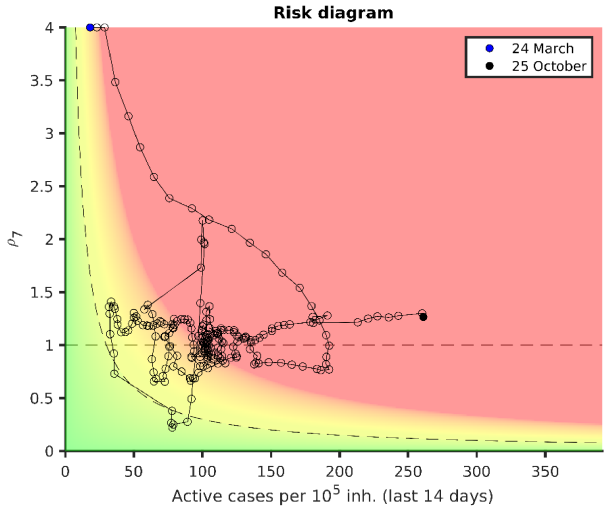
A_{14}	EPG	CFR
261	330	2.29 %

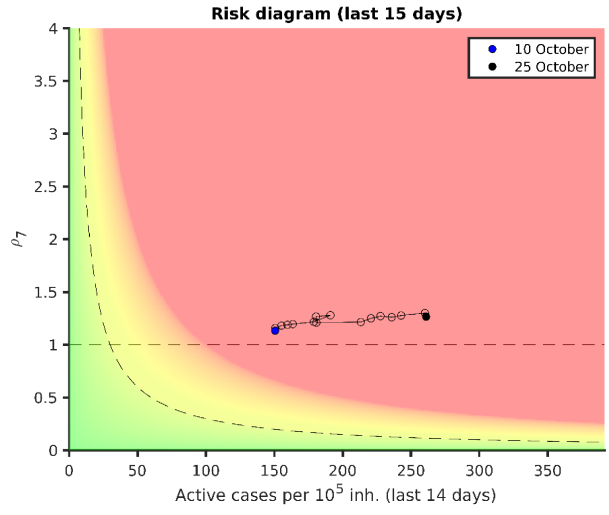




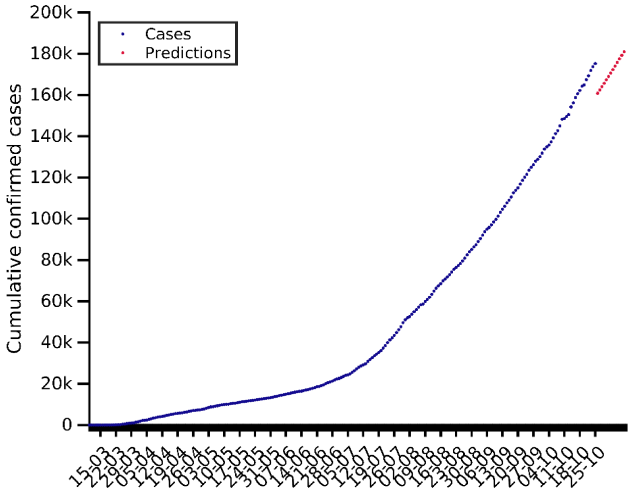








Missouri 25-10-2020. Pop: 6.1M. Cumulative incidence: 2855/10⁵

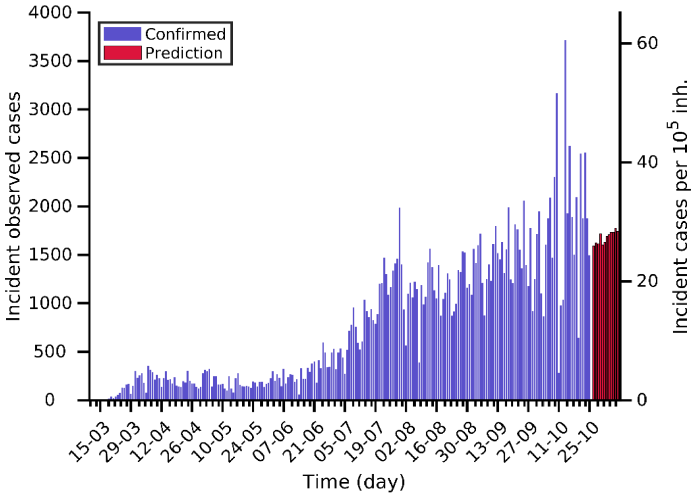


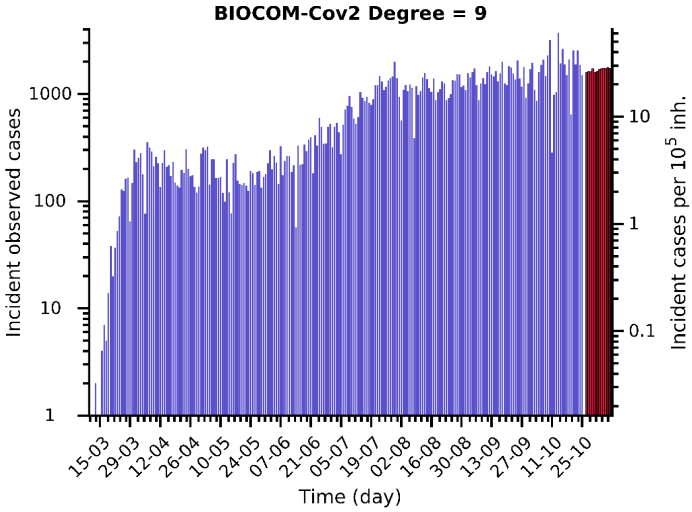
Predictions for next days

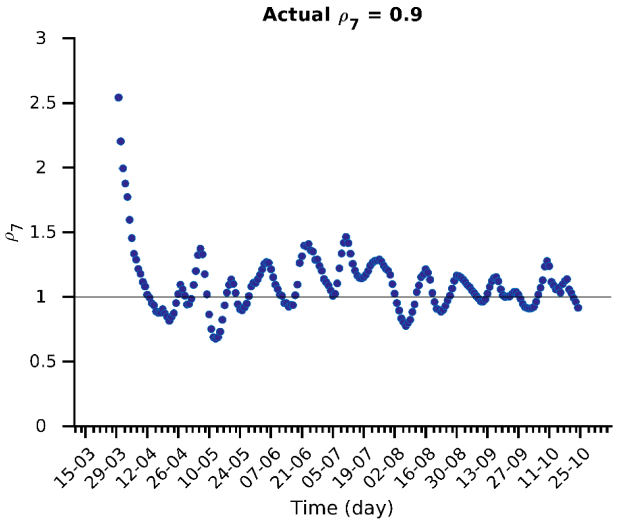
Day	Number of cases
26-10-2020	160829 (+-14410)
28-10-2020	164045 (+1623)
30-10-2020	167376 (+1719)

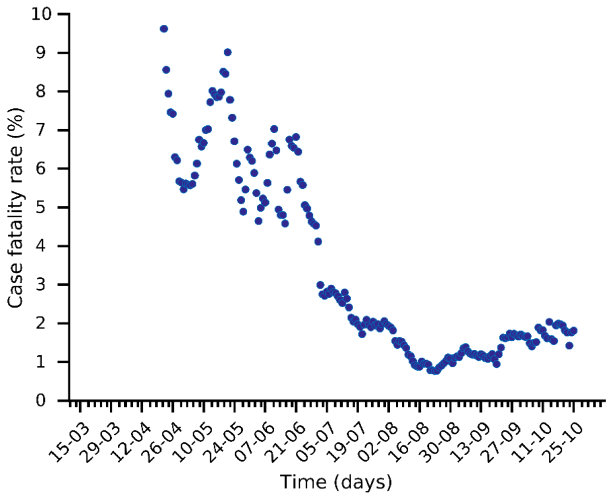
Current indicators

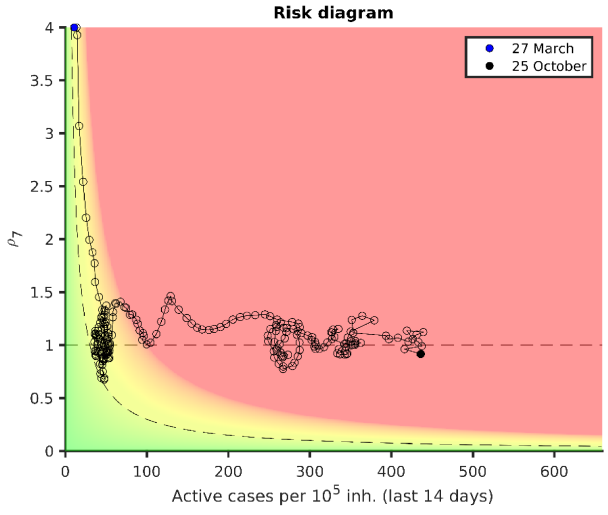
A_{14}	EPG	CFR
436	400	1.81 %

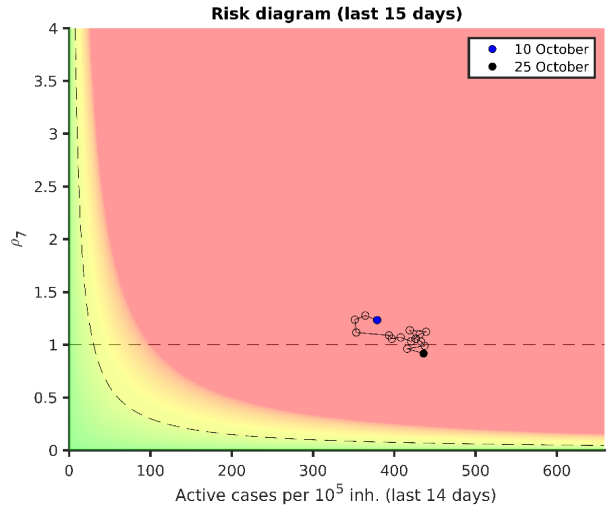




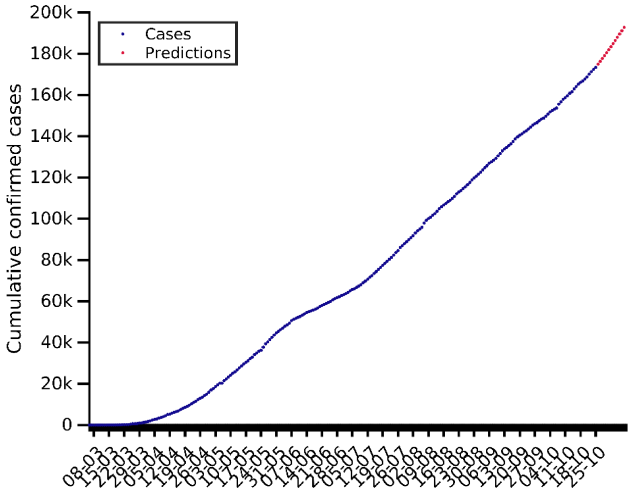








Virginia 25-10-2020. Pop: 8.5M. Cumulative incidence: 2031/10^5

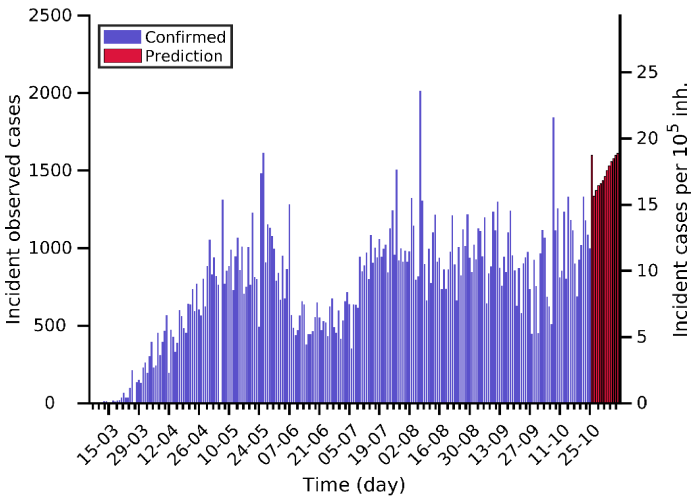


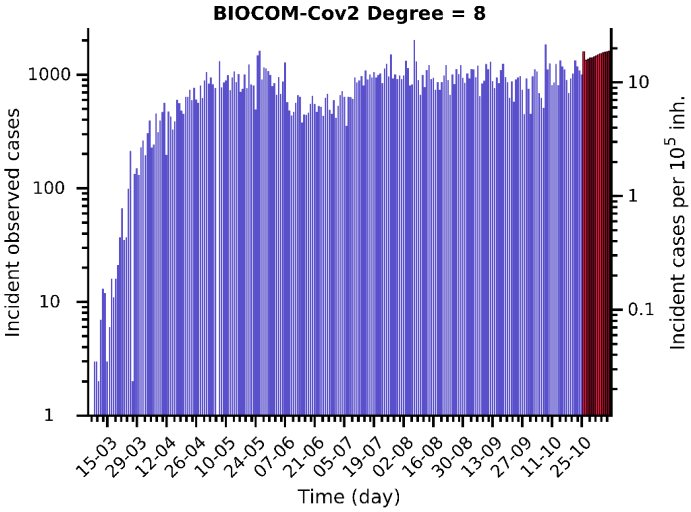
Predictions for next days

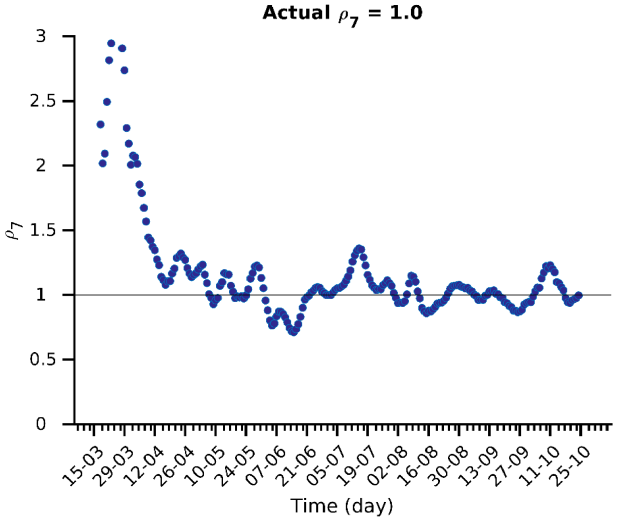
Day	Number of cases
26-10-2020	174971 (+1600)
28-10-2020	177679 (+1372)
30-10-2020	180495 (+1415)

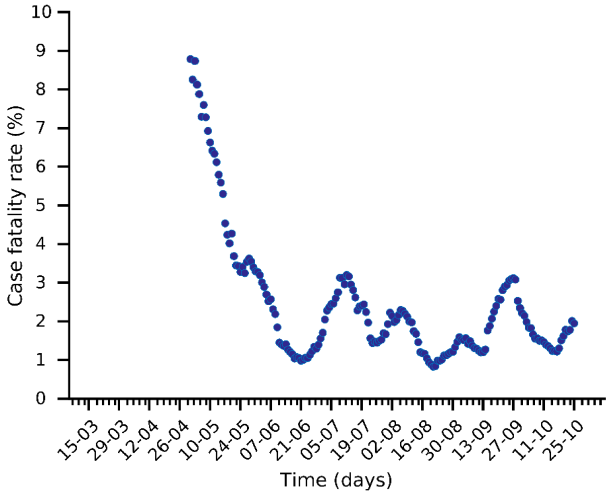
Current indicators

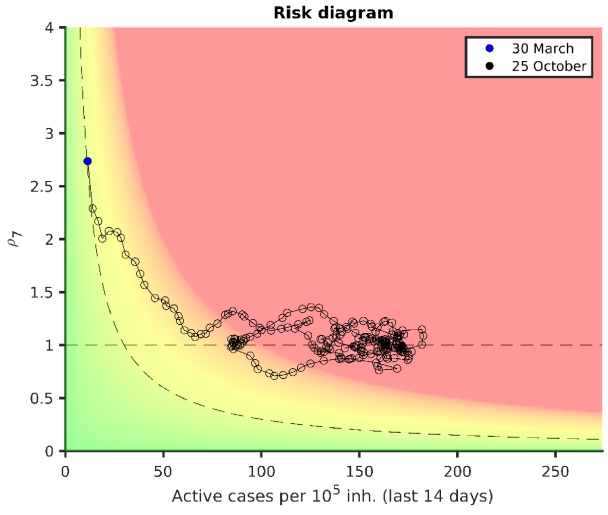
A_{14}	EPG	CFR
172	171	1.95 %

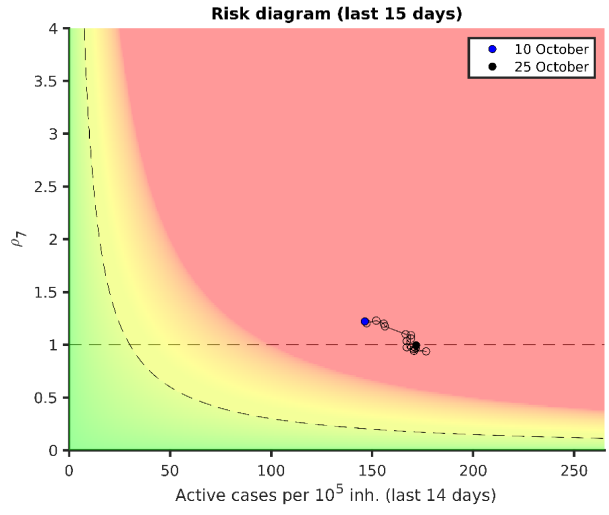




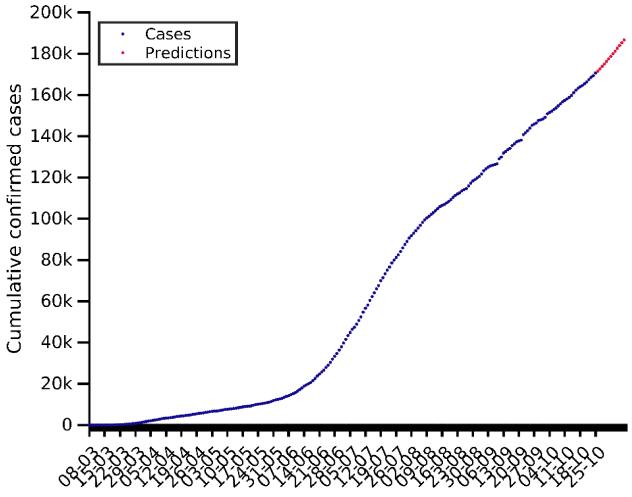








South Carolina 25-10-2020. Pop: 5.1M. Cumulative incidence: 3315/10^5

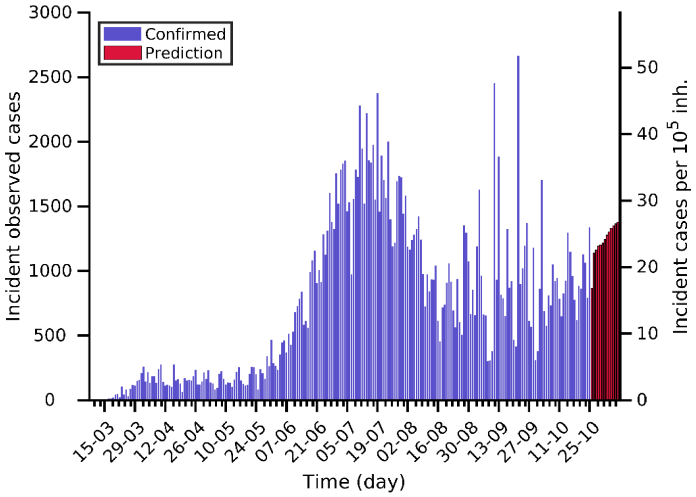


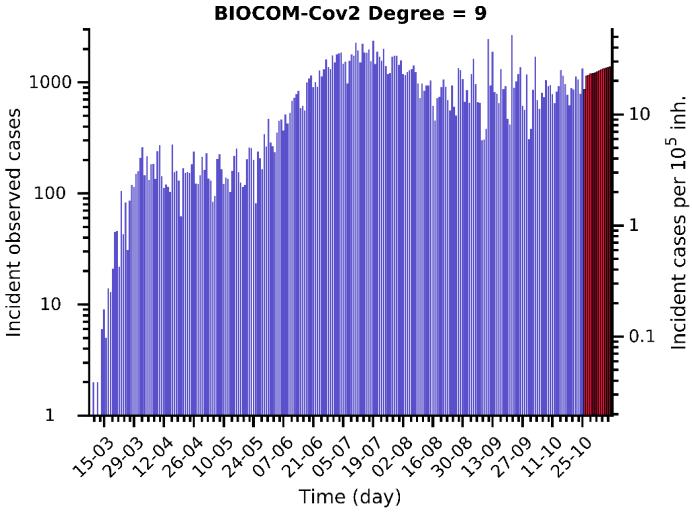
Predictions for next days

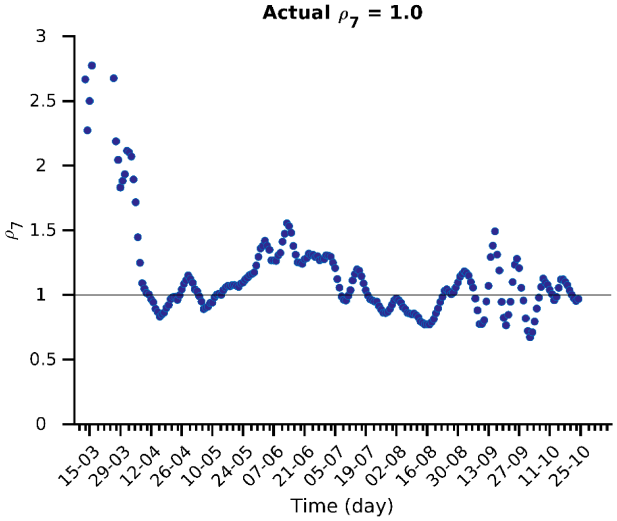
Day	Number of cases
26-10-2020	171542 (+864)
28-10-2020	173844 (+1163)
30-10-2020	176240 (+1203)

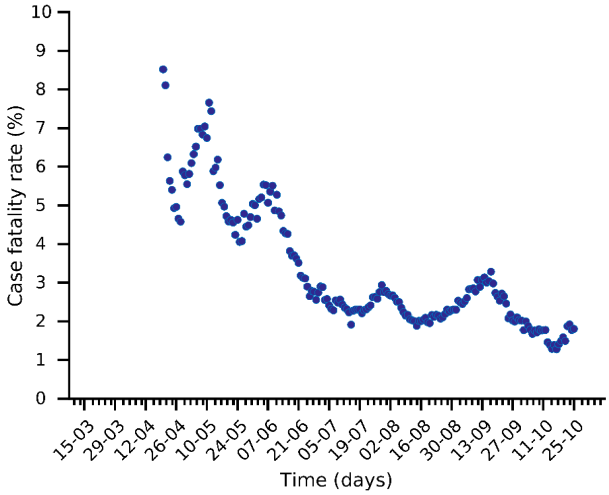
Current indicators

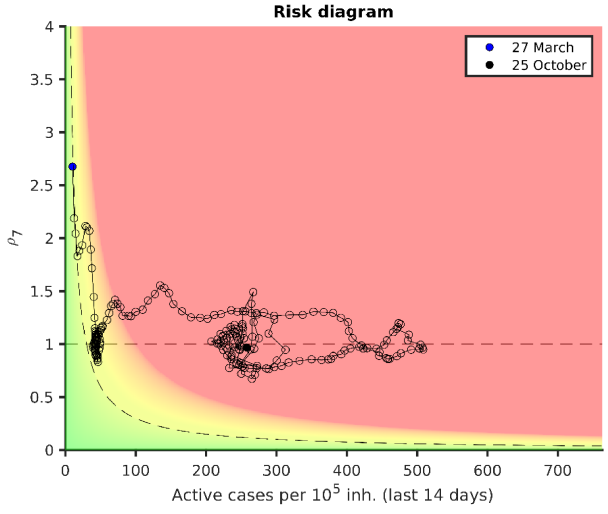
A_{14}	EPG	CFR
258	249	1.80 %

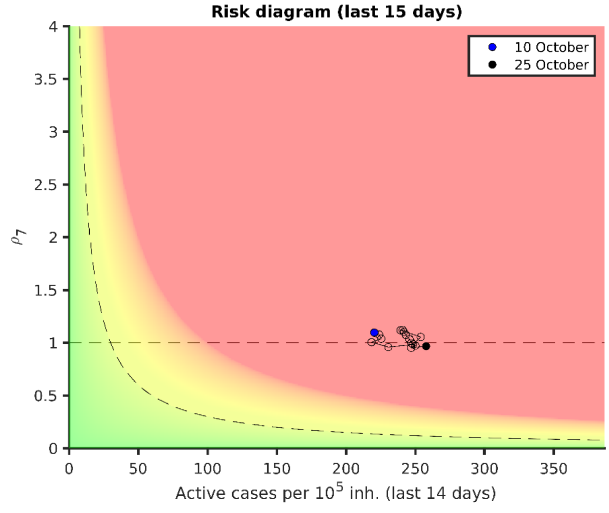




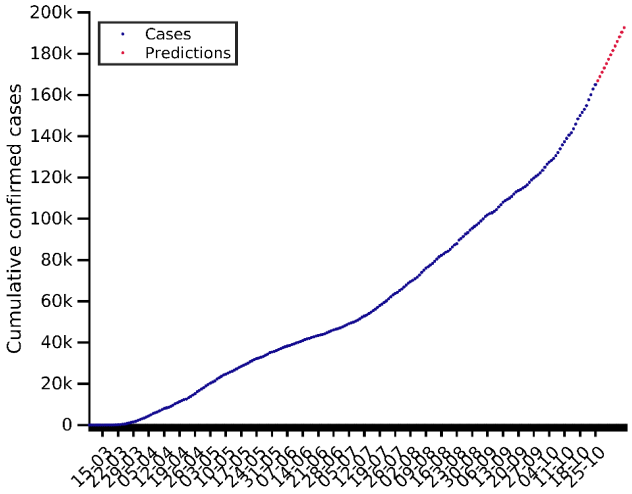








Indiana 25-10-2020. Pop: 6.7M. Cumulative incidence: 2451/10⁵

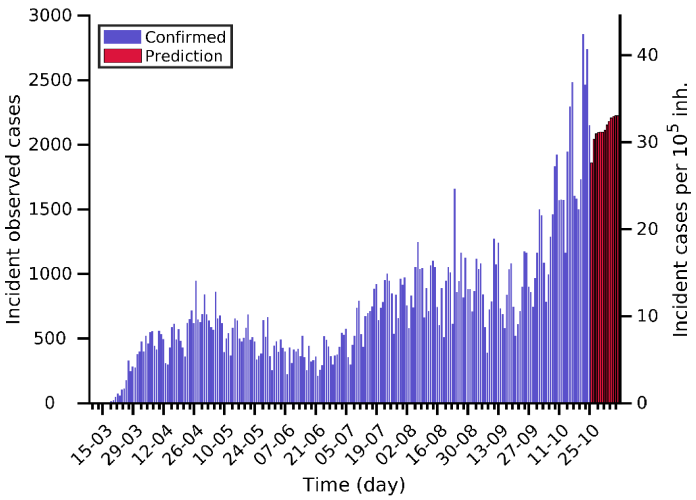


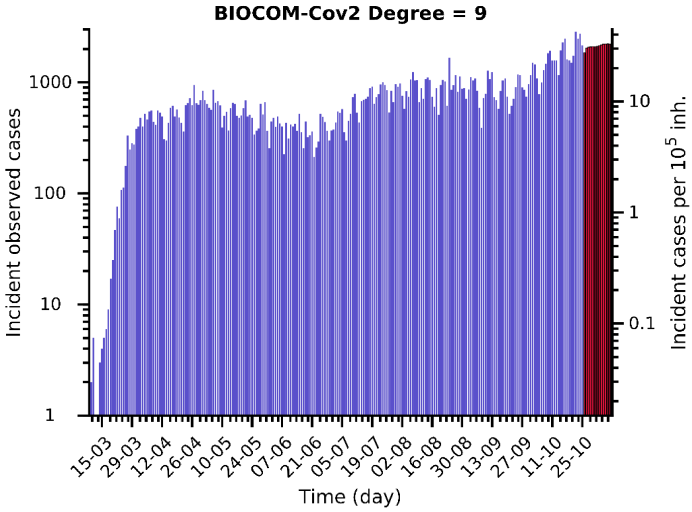
Predictions for next days

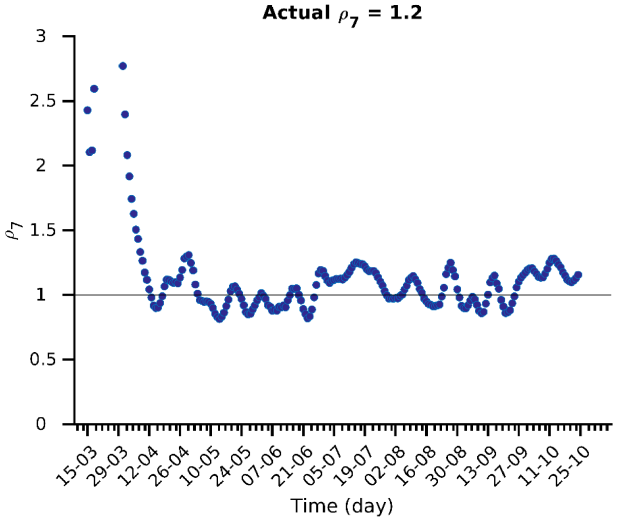
Day	Number of cases
26-10-2020	166897 (+1859)
28-10-2020	171027 (+2085)
30-10-2020	175221 (+2100)

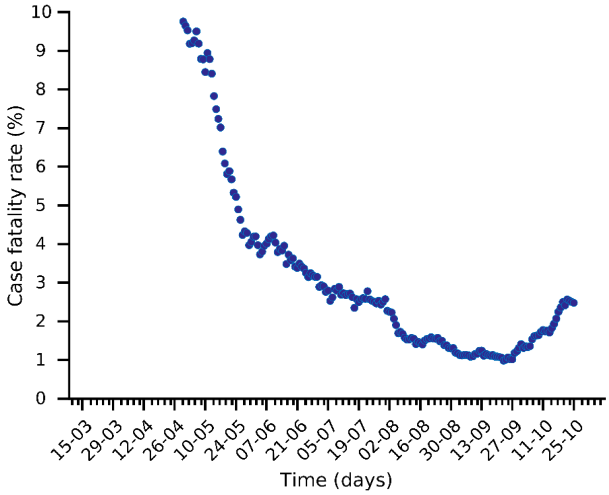
Current indicators

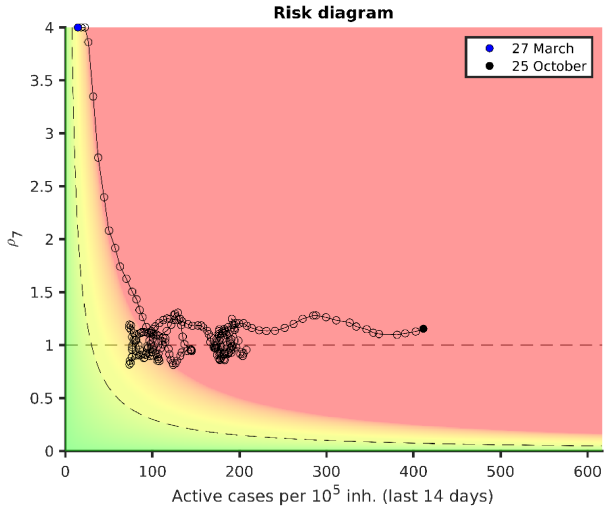
A_{14}	EPG	CFR
411	475	2.48 %

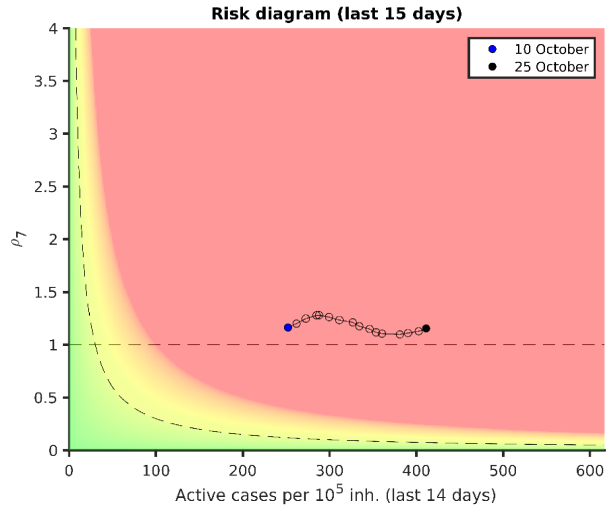




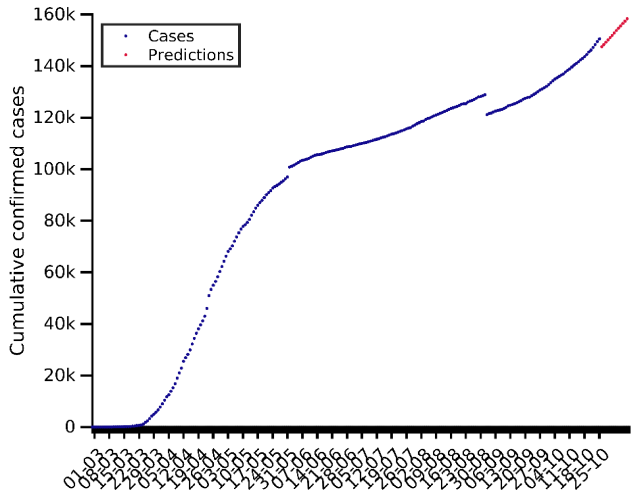








Massachusetts 25-10-2020. Pop: 6.9M. Cumulative incidence: 2184/10^5

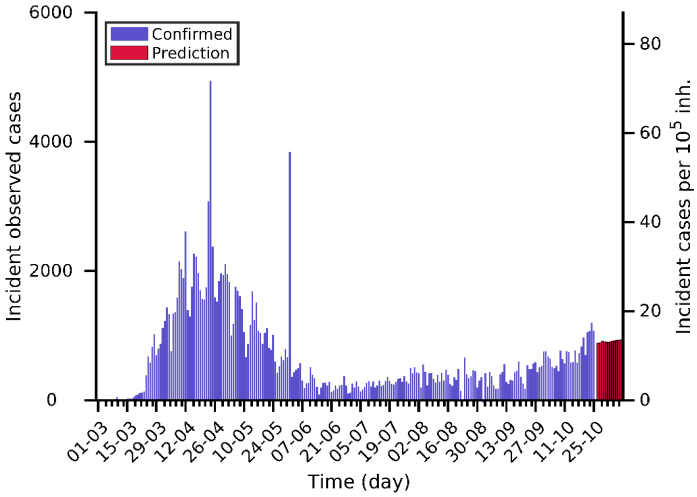


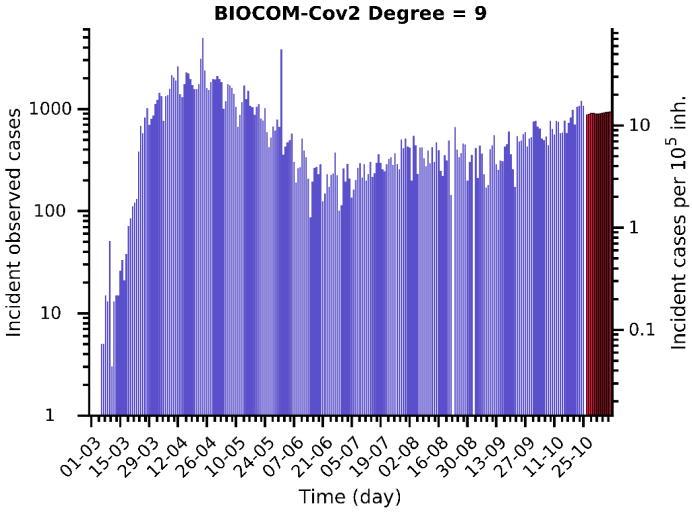
Predictions for next days

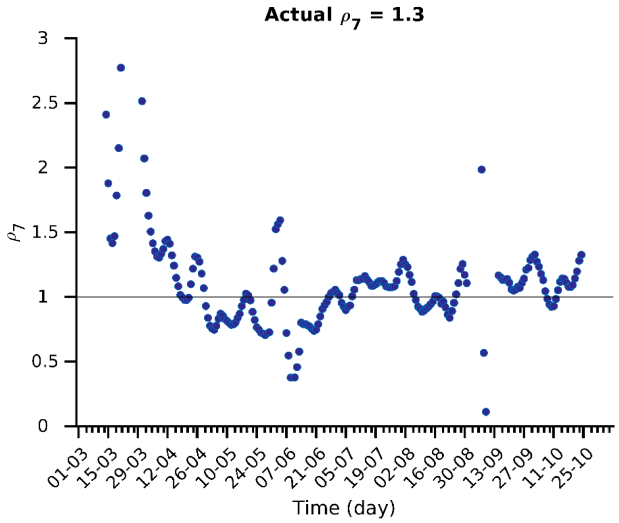
Day	Number of cases
26-10-2020	147452 (+-3113)
28-10-2020	149224 (+892)
30-10-2020	151044 (+906)

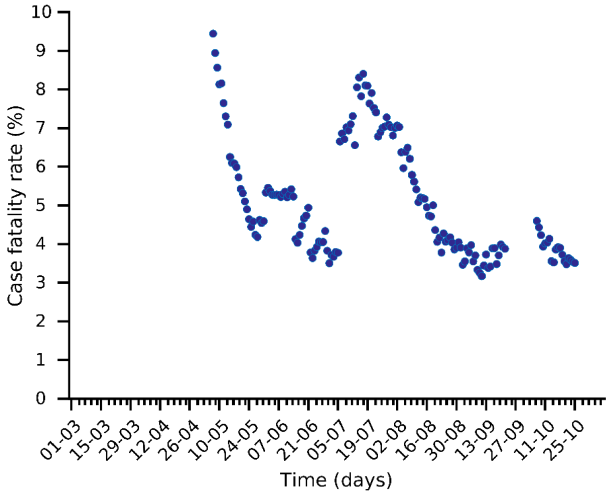
Current indicators

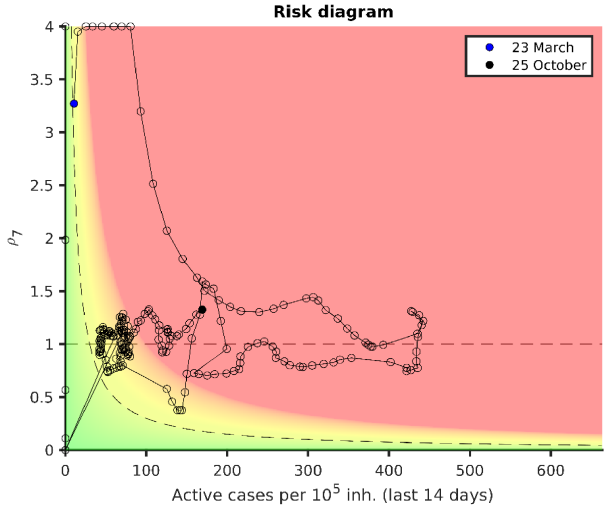
A_{14}	EPG	CFR
169	224	3.51 %

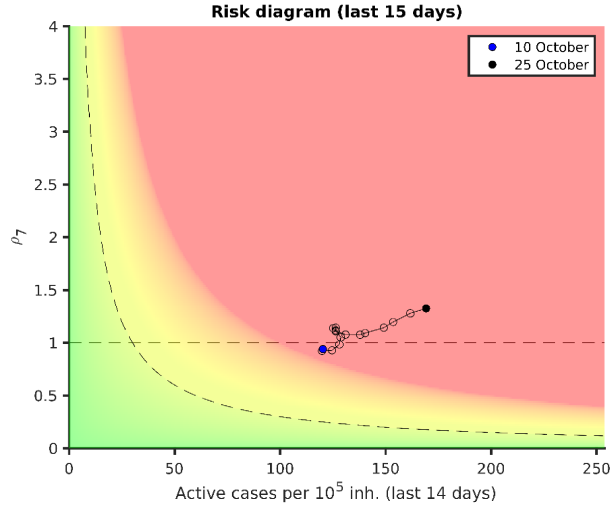




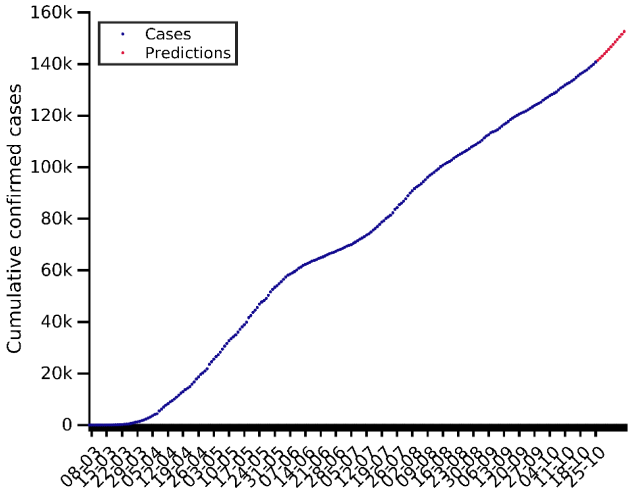








Maryland 25-10-2020. Pop: 6.0M. Cumulative incidence: 2328/10^5

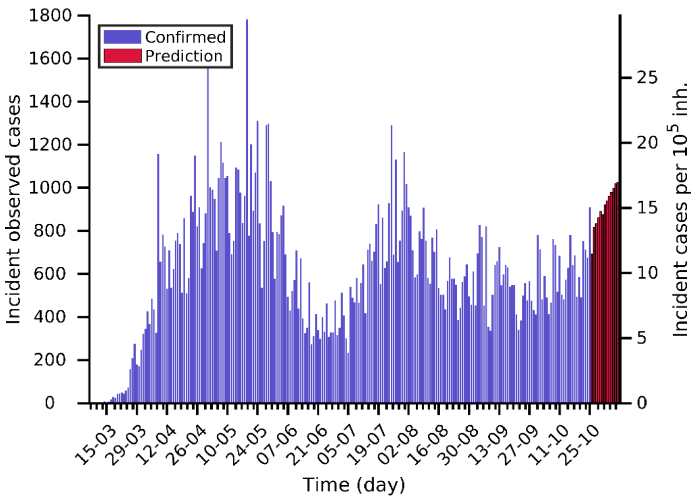


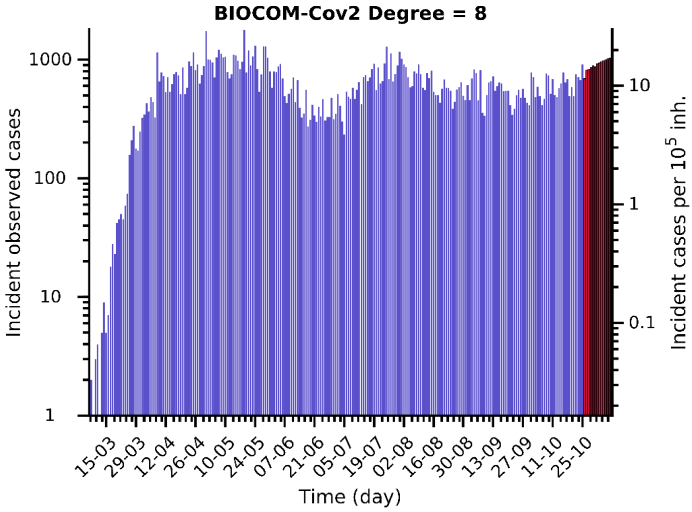
Predictions for next days

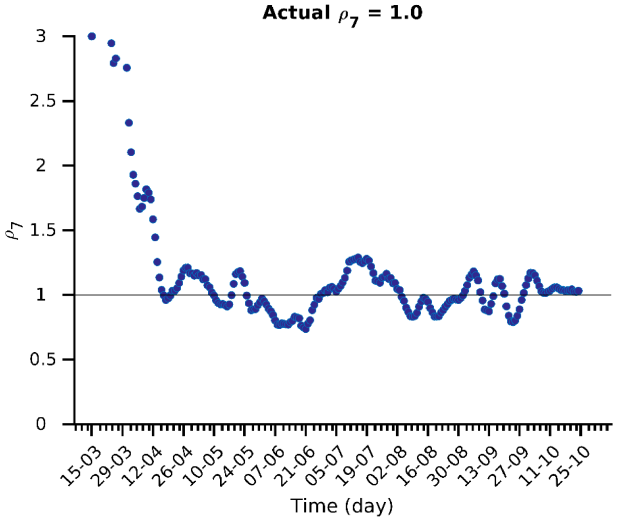
Day	Number of cases
26-10-2020	141463 (+693)
28-10-2020	143114 (+833)
30-10-2020	144867 (+891)

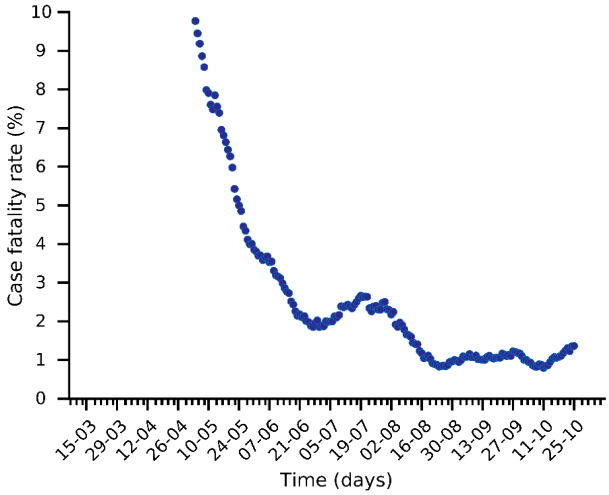
Current indicators

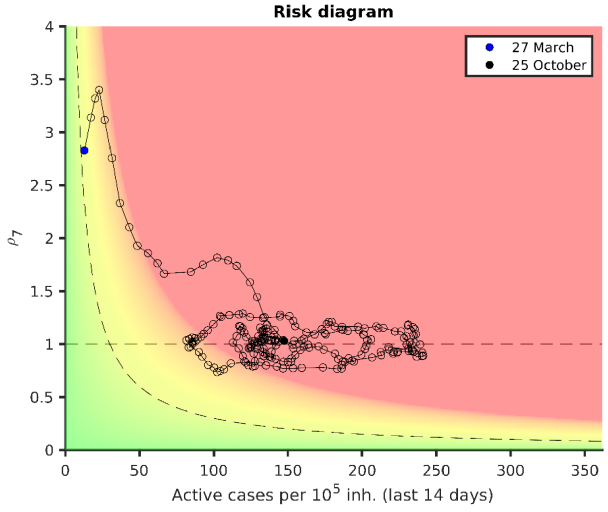
A_{14}	EPG	CFR
147	152	1.36 %

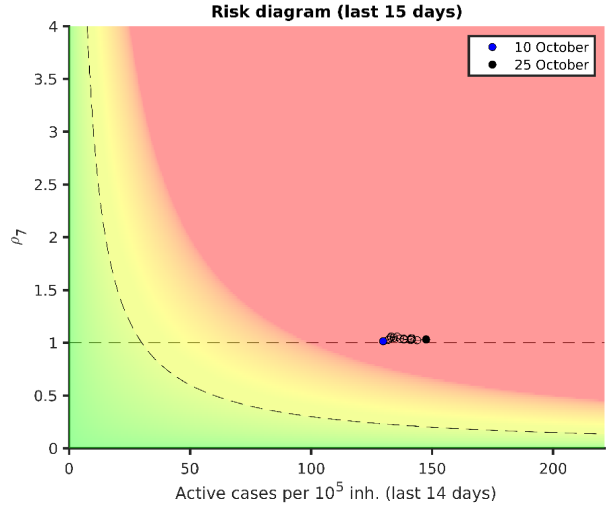




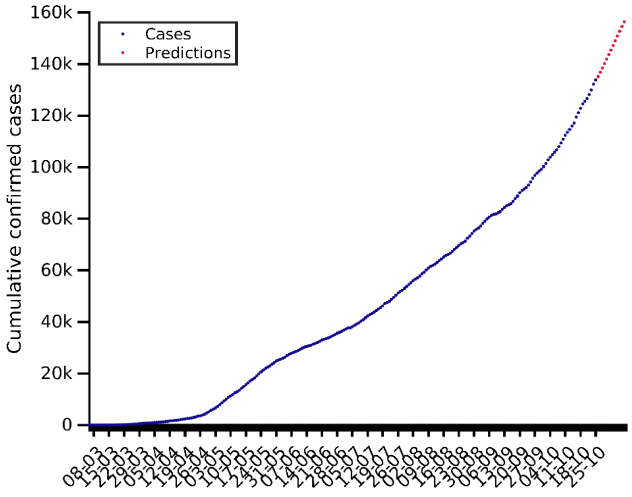








Minnesota 25-10-2020. Pop: 5.6M. Cumulative incidence: 2373/10^5

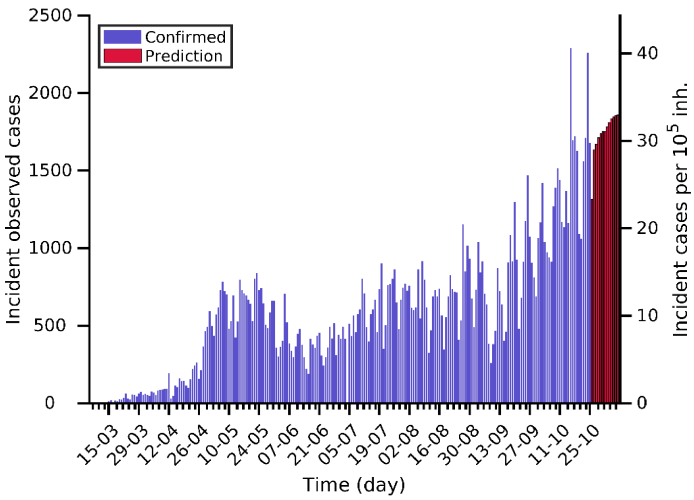


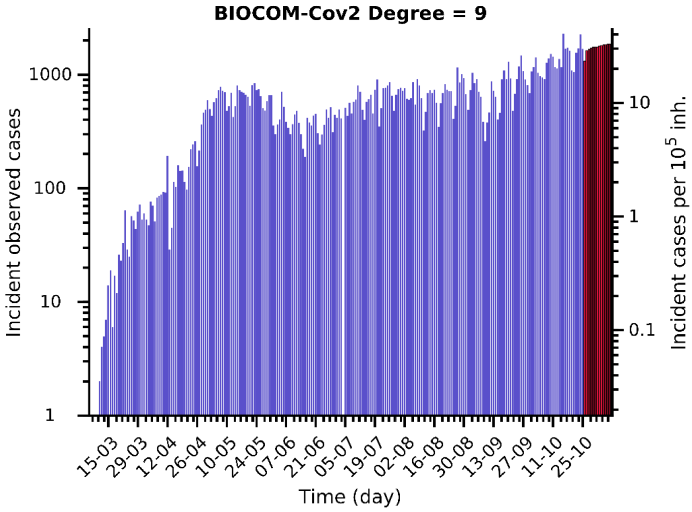
Predictions for next days

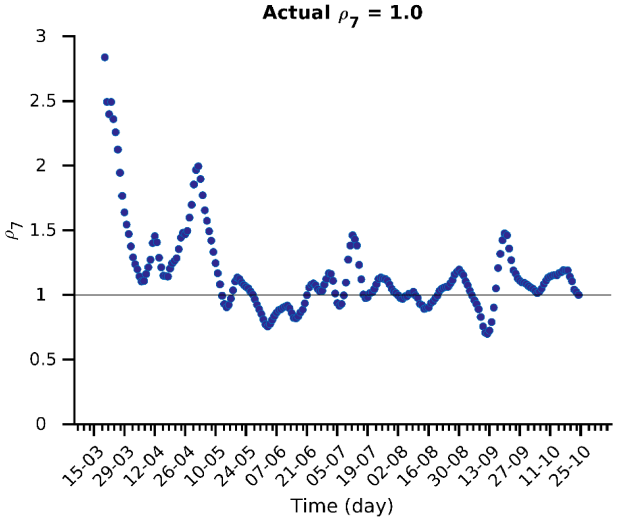
Day	Number of cases
26-10-2020	135169 (+1314)
28-10-2020	138473 (+1670)
30-10-2020	141924 (+1739)

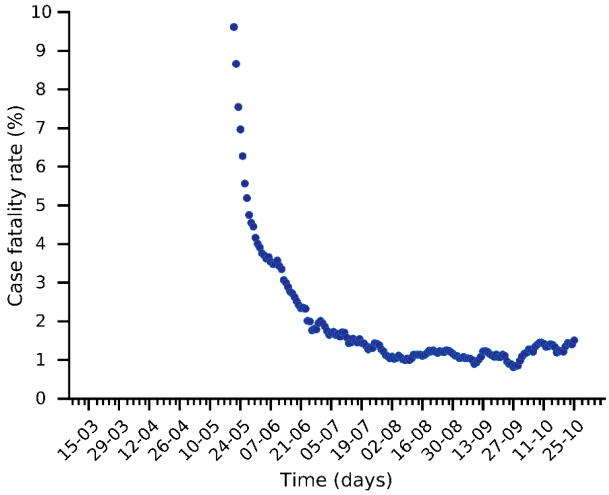
Current indicators

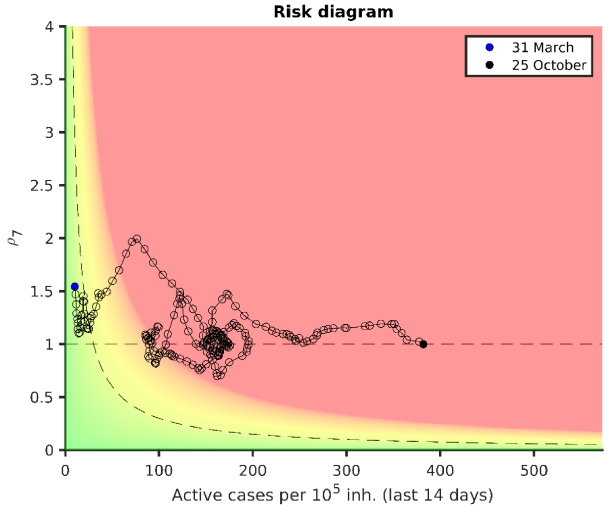
A_{14}	EPG	CFR
382	382	1.51 %

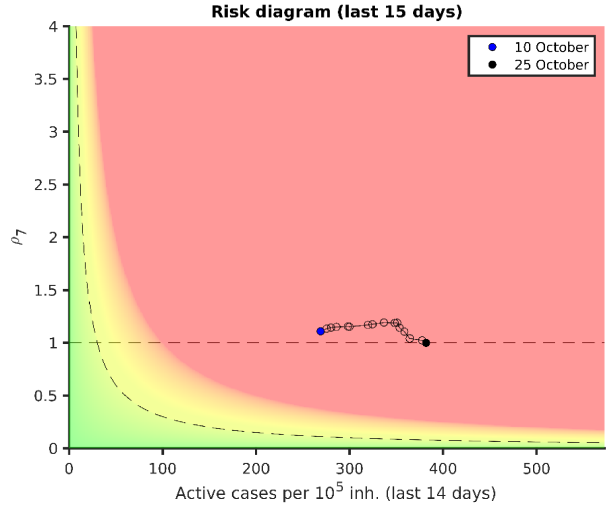




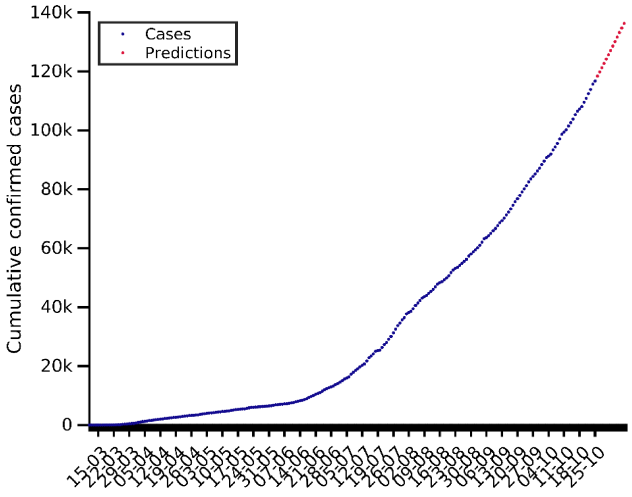








Oklahoma 25-10-2020. Pop: 4.0M. Cumulative incidence: 2950/10⁵

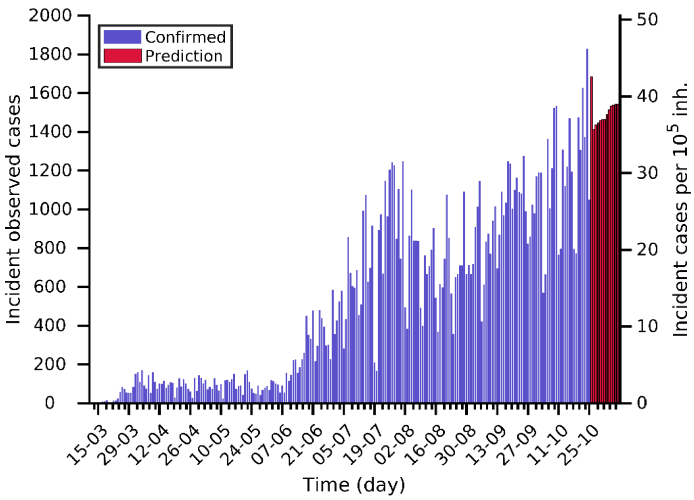


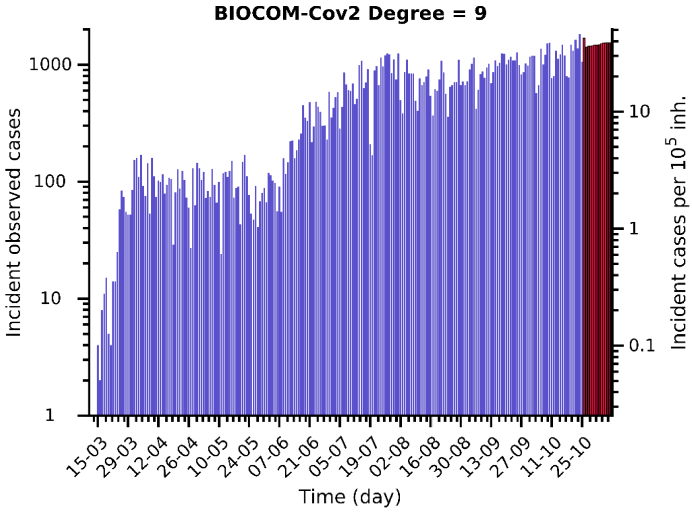
Predictions for next days

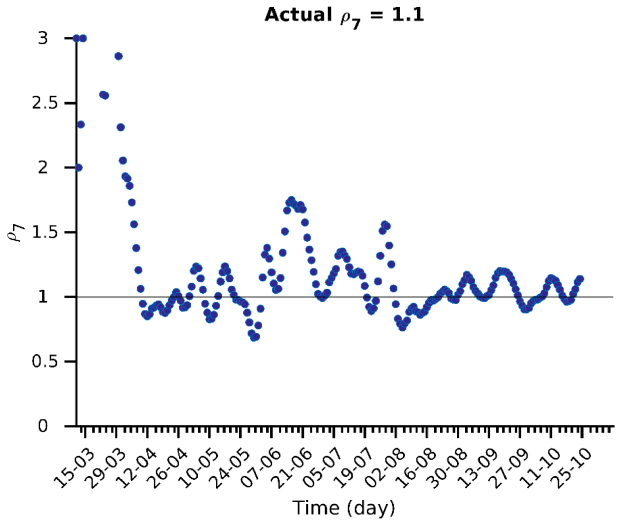
Day	Number of cases
26-10-2020	118420 (+1684)
28-10-2020	121268 (+1436)
30-10-2020	124174 (+1460)

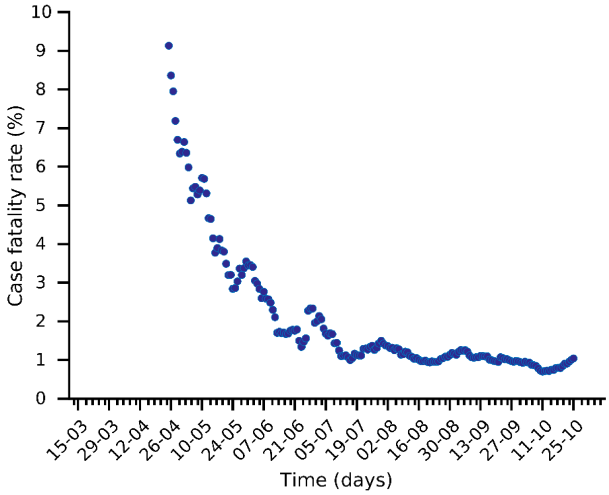
Current indicators

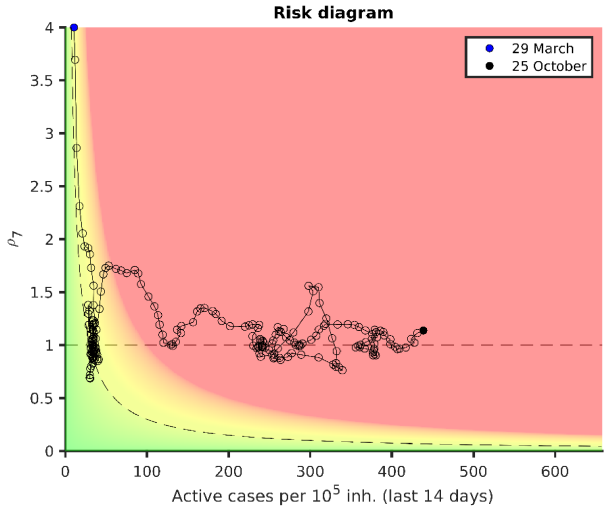
A_{14}	EPG	CFR
438	499	1.04 %

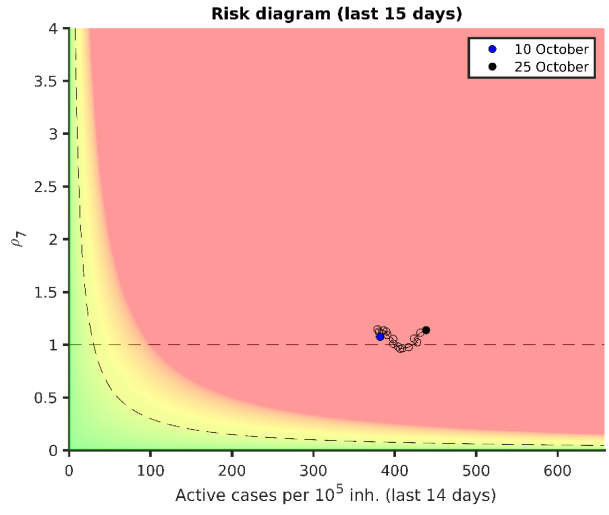




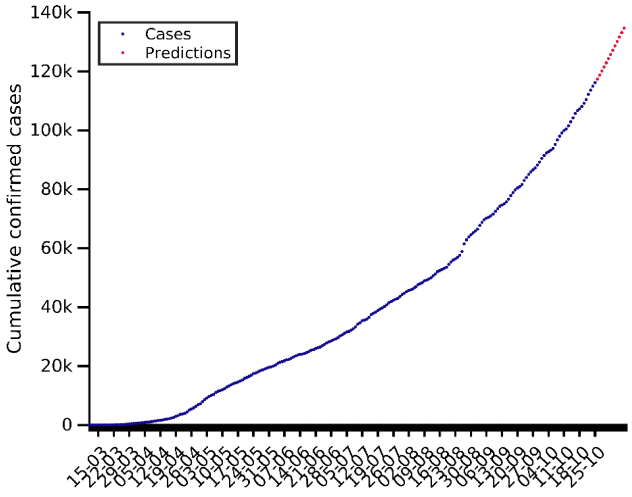








Iowa 25-10-2020. Pop: 3.2M. Cumulative incidence: 3684/10⁵

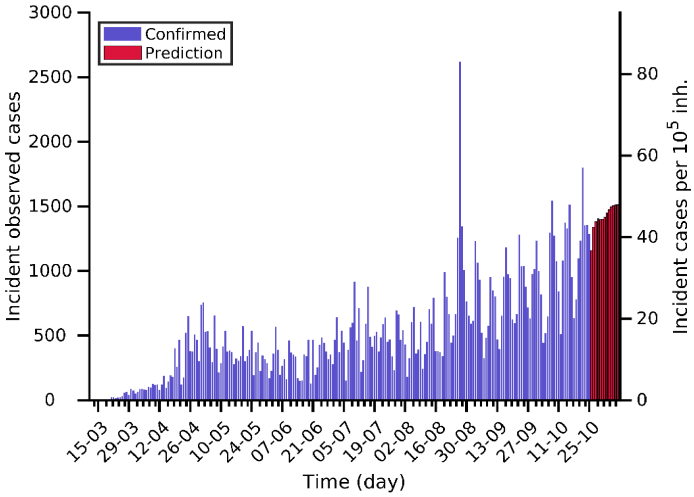


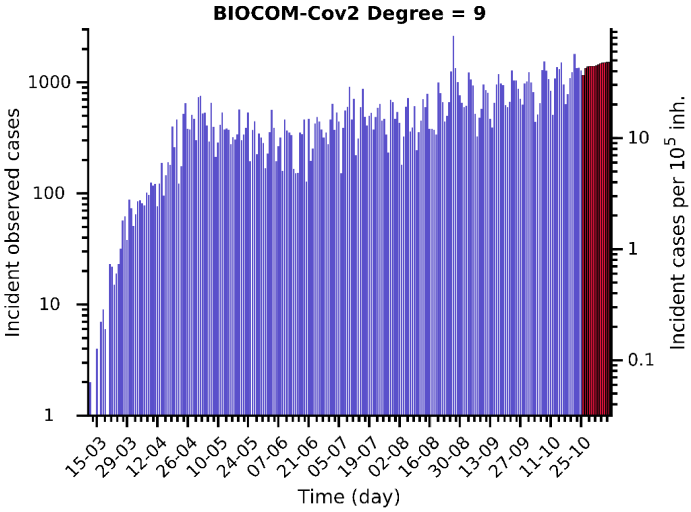
Predictions for next days

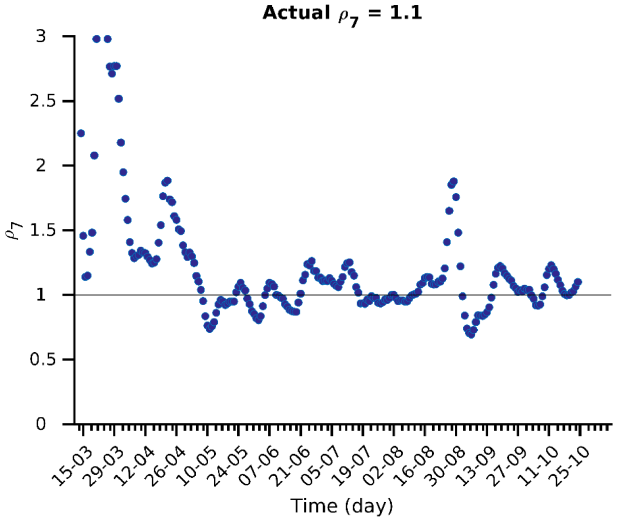
Day	Number of cases
26-10-2020	117396 (+1158)
28-10-2020	120115 (+1380)
30-10-2020	122917 (+1399)

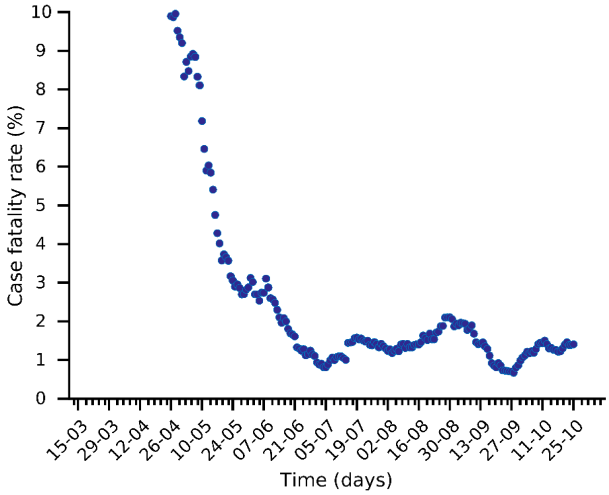
Current indicators

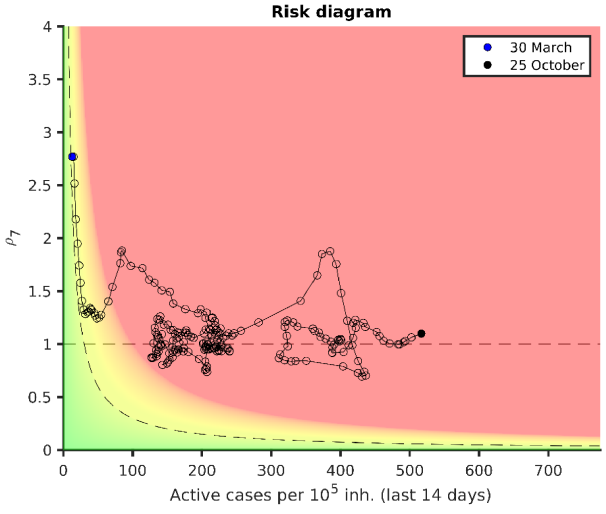
A_{14}	EPG	CFR
517	568	1.40 %

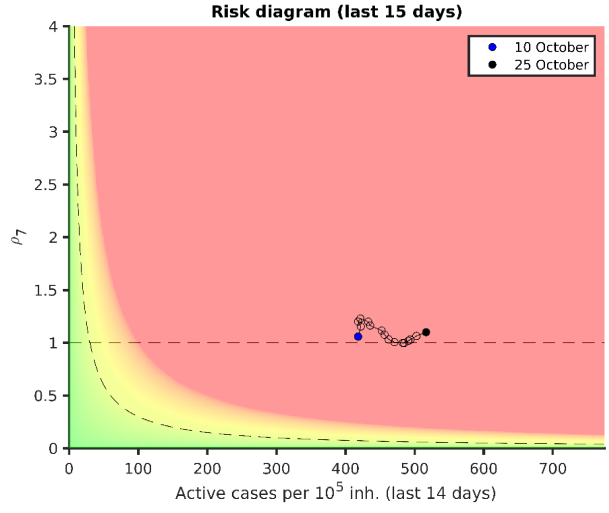




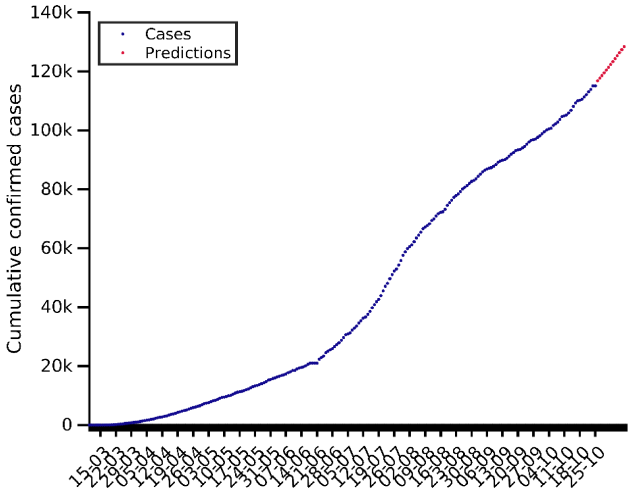








Mississippi 25-10-2020. Pop: 3.0M. Cumulative incidence: 3867/10⁵

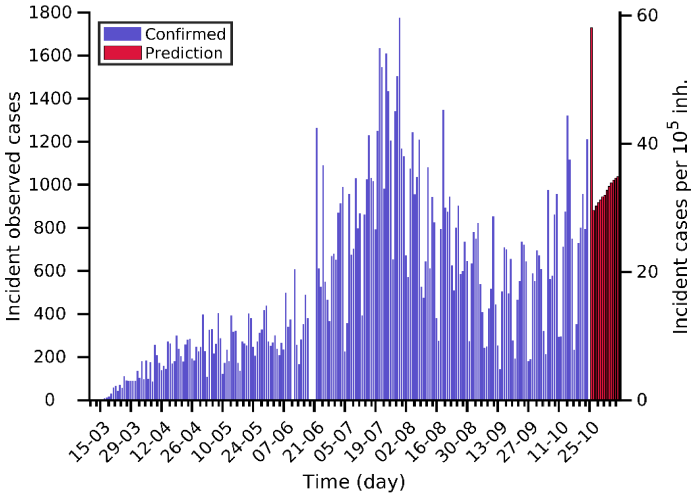


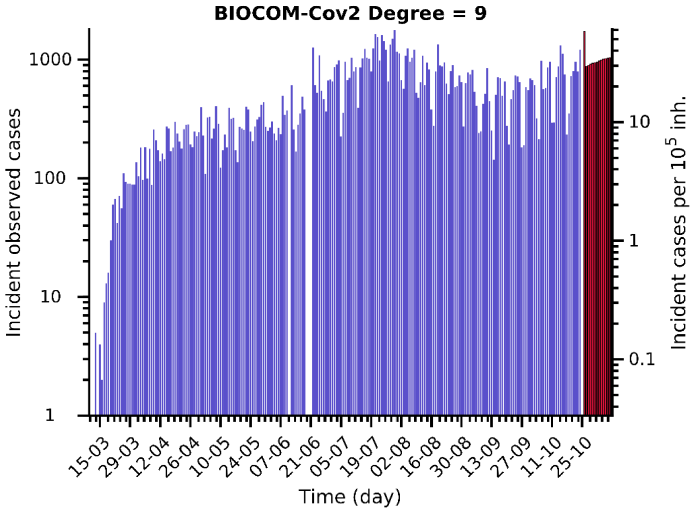
Predictions for next days

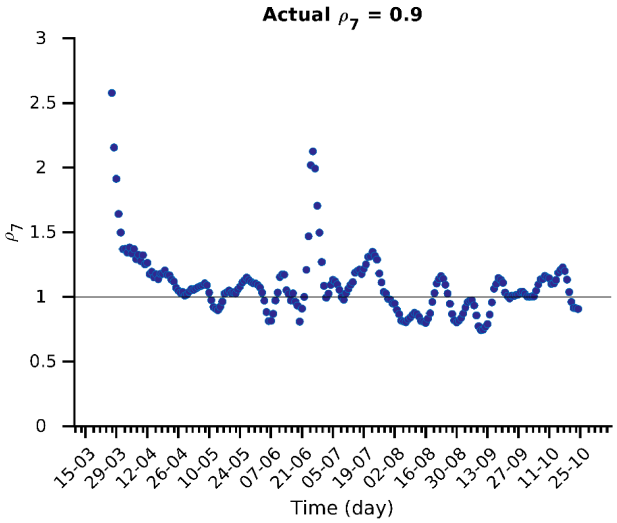
Day	Number of cases
26-10-2020	116818 (+1730)
28-10-2020	118601 (+901)
30-10-2020	120449 (+930)

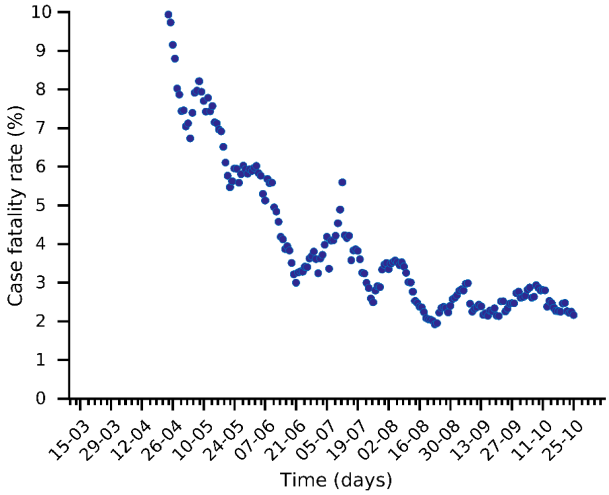
Current indicators

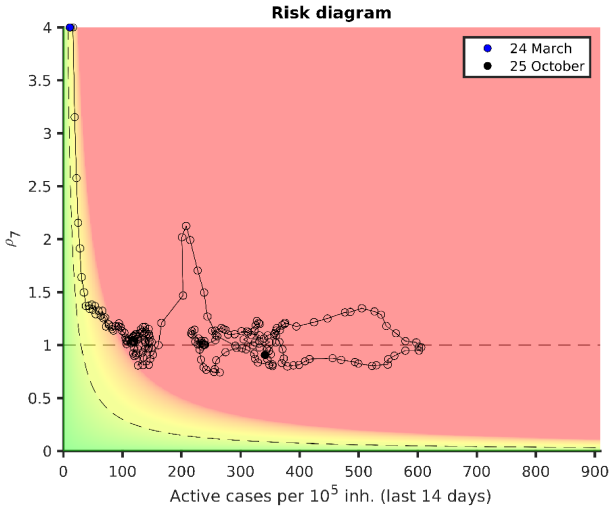
A_{14}	EPG	CFR
341	309	2.16 %

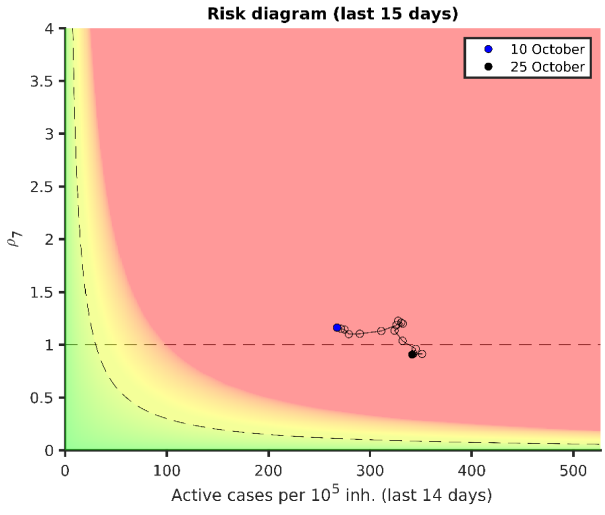




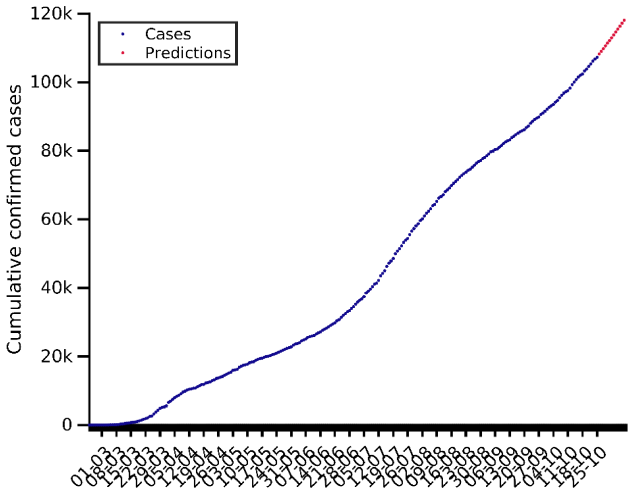








Washington 25-10-2020. Pop: 7.6M. Cumulative incidence: 1409/10^5

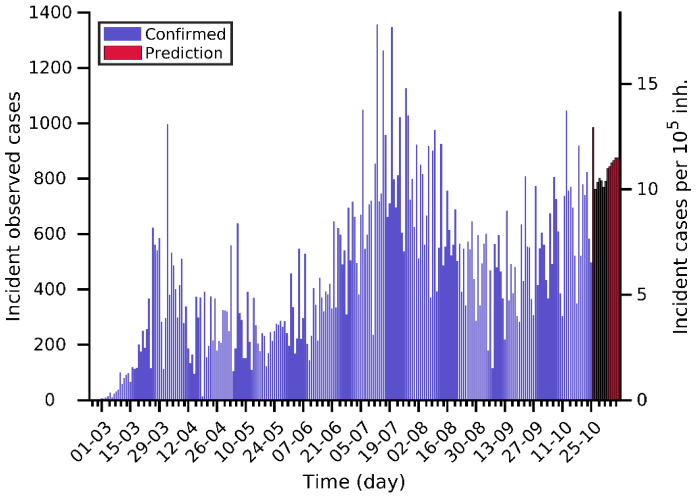


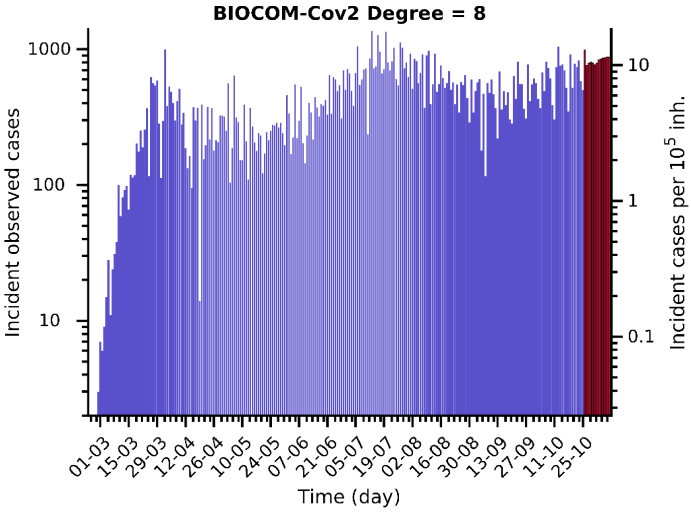
Predictions for next days

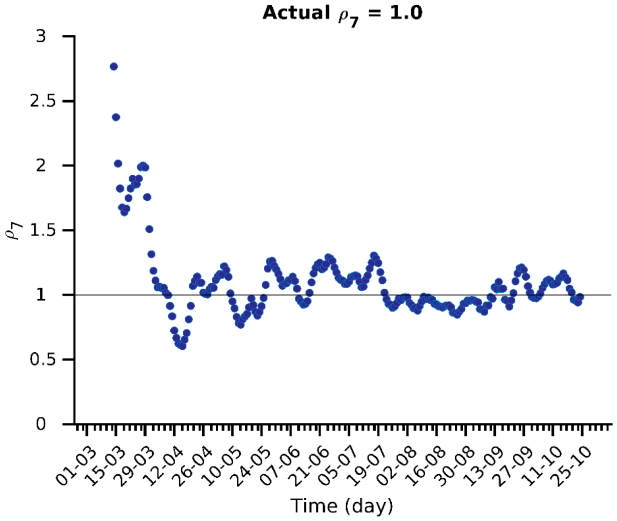
Day	Number of cases
26-10-2020	108255 (+985)
28-10-2020	109804 (+788)
30-10-2020	111399 (+792)

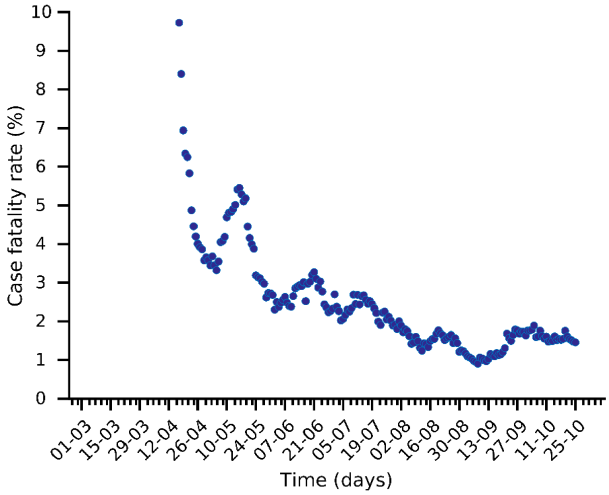
Current indicators

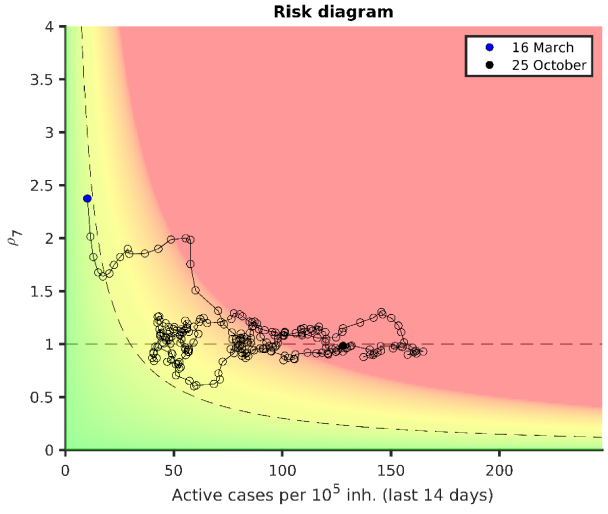
A_{14}	EPG	CFR
128	126	1.45 %

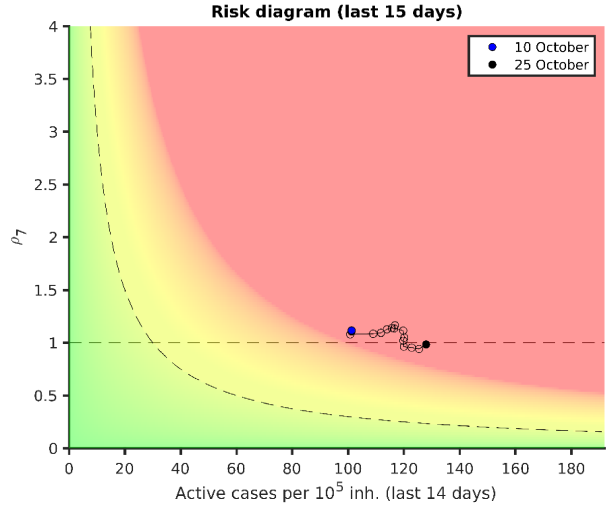




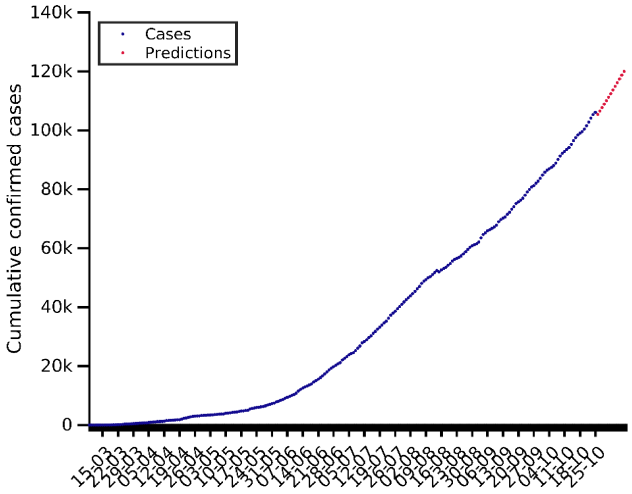








Arkansas 25-10-2020. Pop: 3.0M. Cumulative incidence: 3516/10⁵

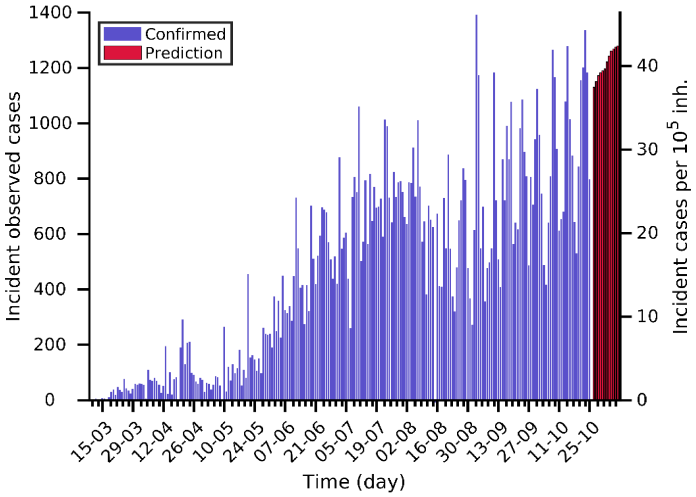


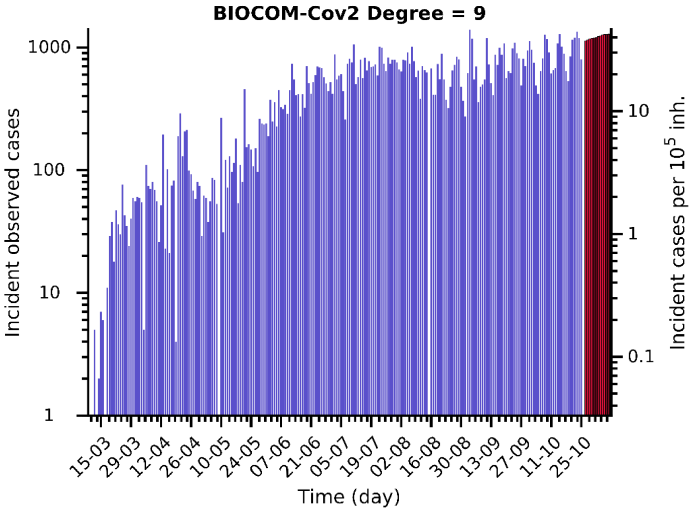
Predictions for next days

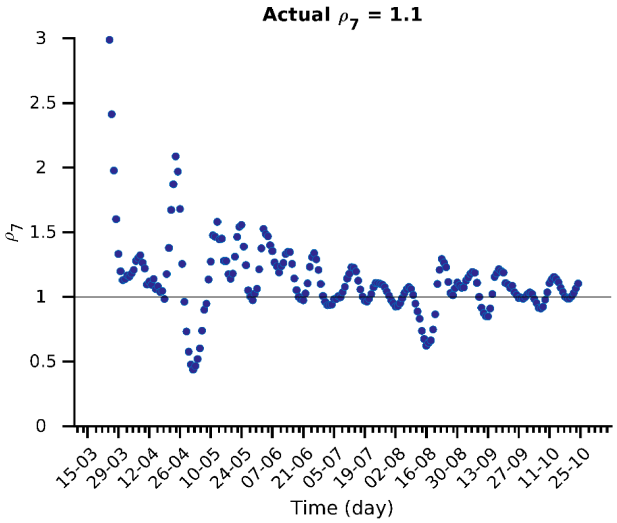
Day	Number of cases
26-10-2020	105431 (+-684)
28-10-2020	107712 (+1151)
30-10-2020	110067 (+1182)

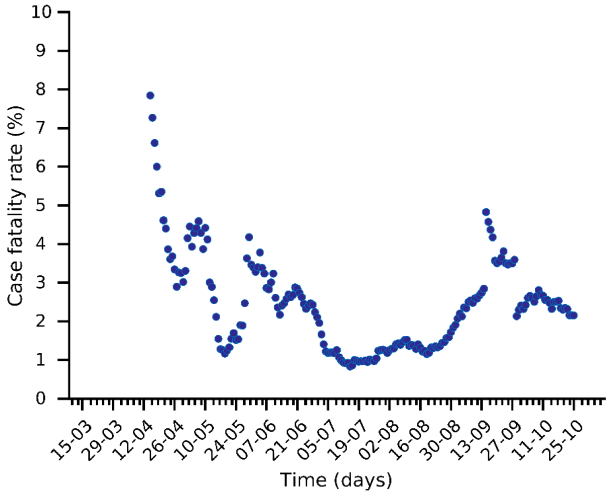
Current indicators

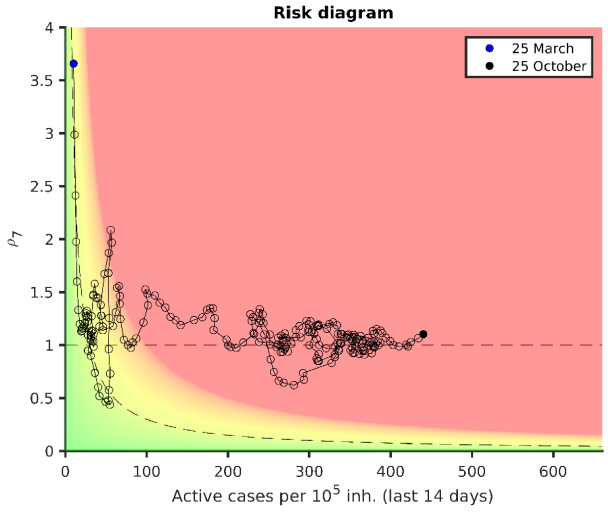
A_{14}	EPG	CFR
440	486	2.15 %

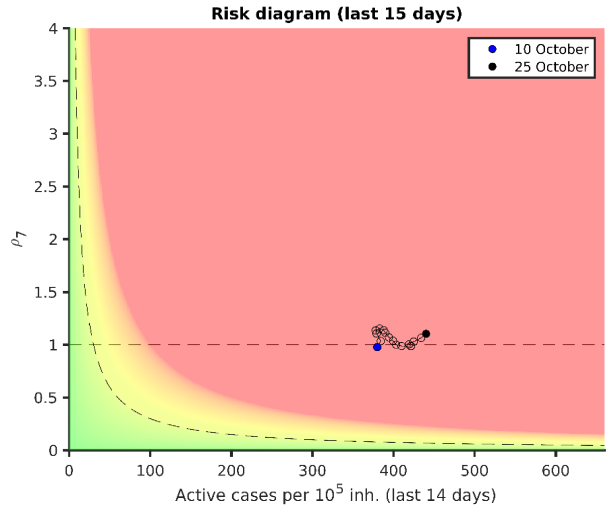




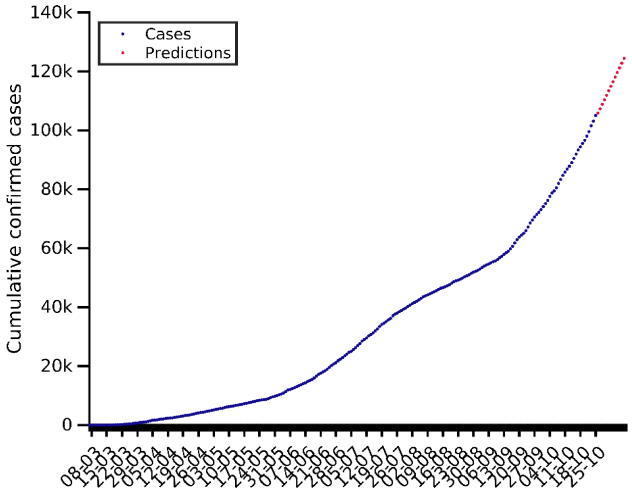








Utah 25-10-2020. Pop: 3.2M. Cumulative incidence: 3277/10⁵

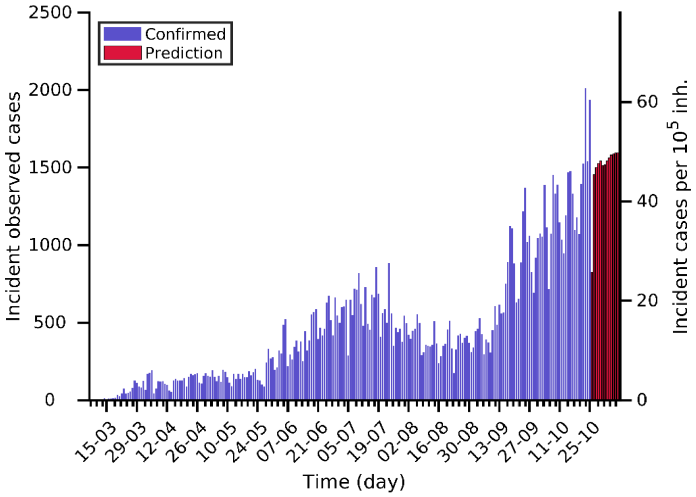


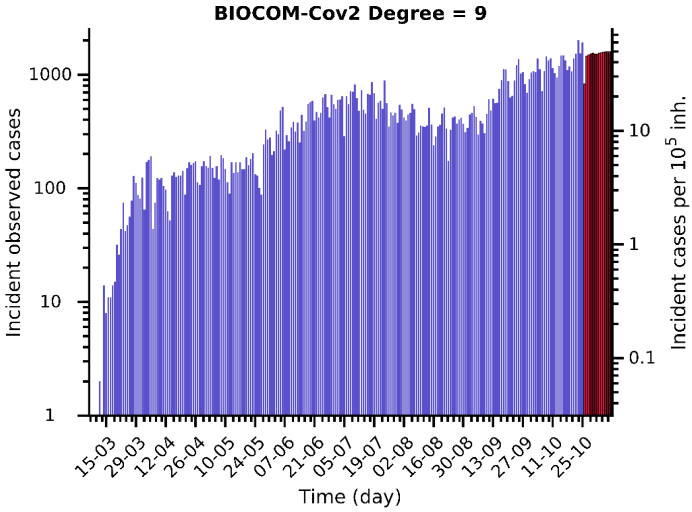
Predictions for next days

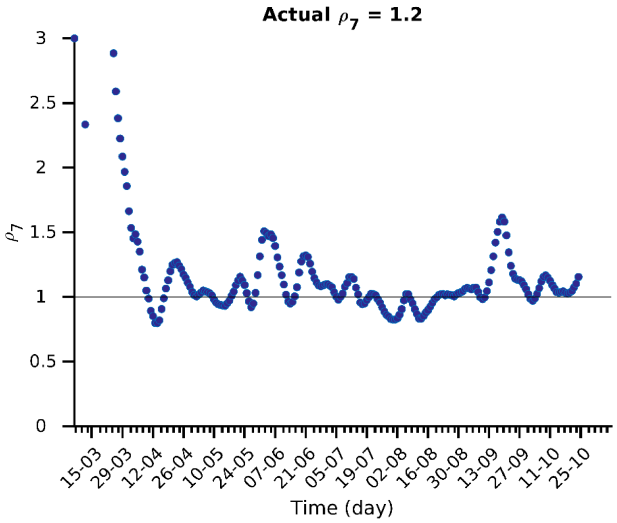
Day	Number of cases
26-10-2020	105878 (+825)
28-10-2020	108835 (+1501)
30-10-2020	111905 (+1543)

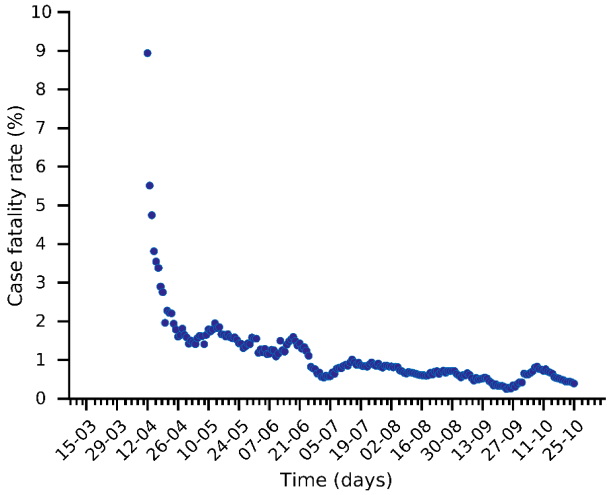
Current indicators

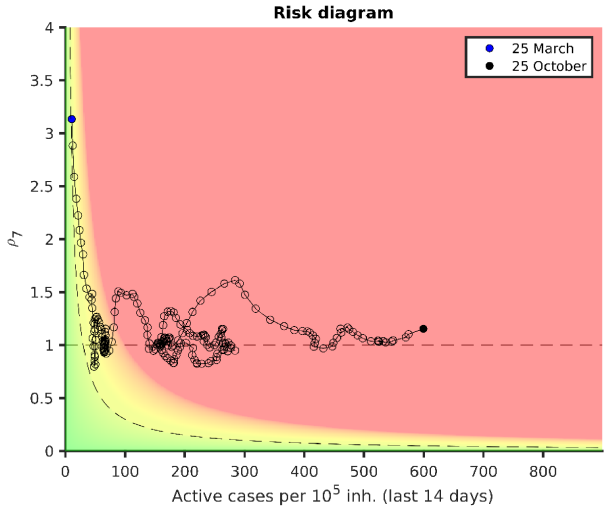
A_{14}	EPG	CFR
599	692	0.39 %

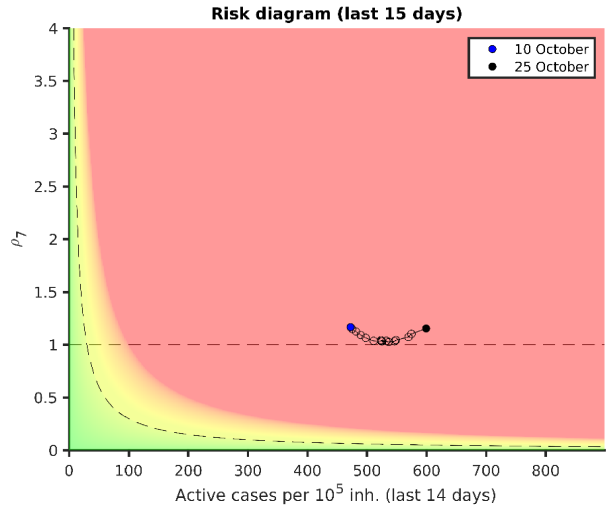




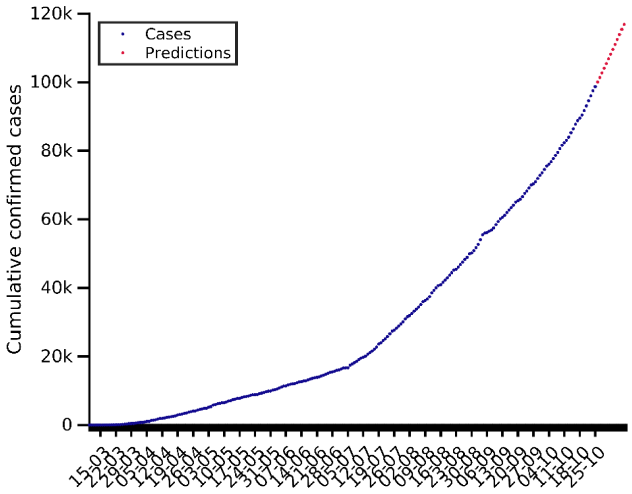








Kentucky 25-10-2020. Pop: 4.5M. Cumulative incidence: 2210/10^5

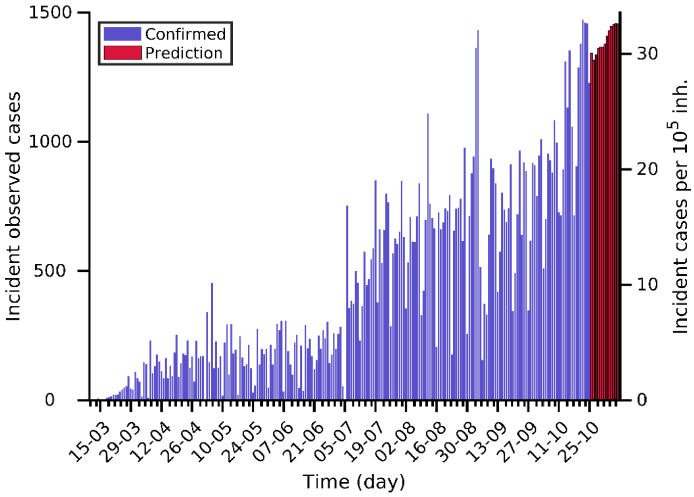


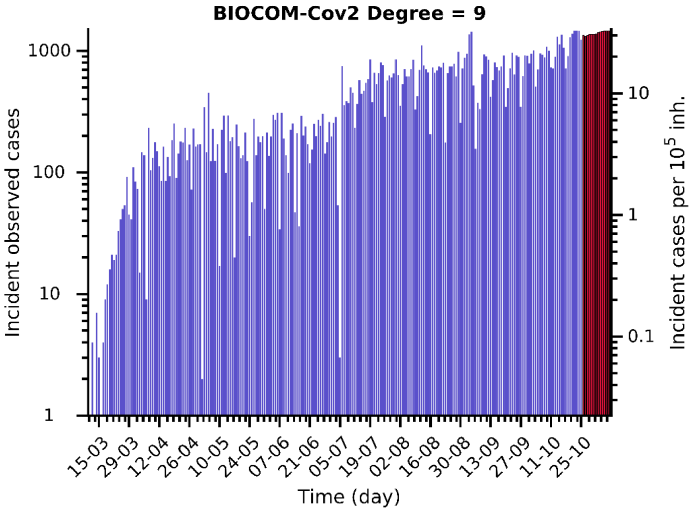
Predictions for next days

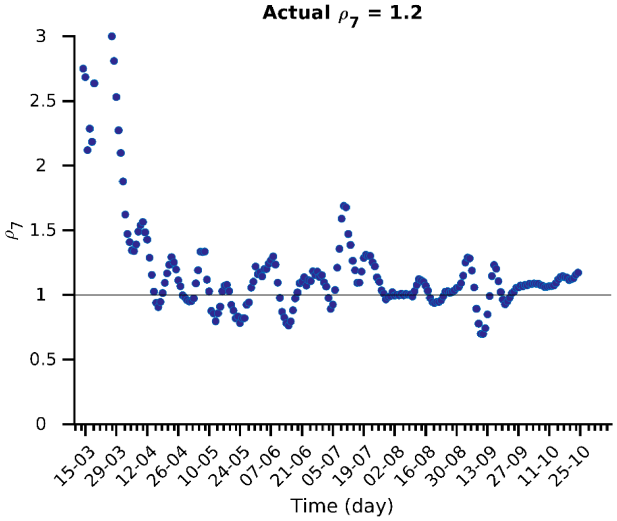
Day	Number of cases
26-10-2020	100073 (+1343)
28-10-2020	102726 (+1338)
30-10-2020	105454 (+1367)

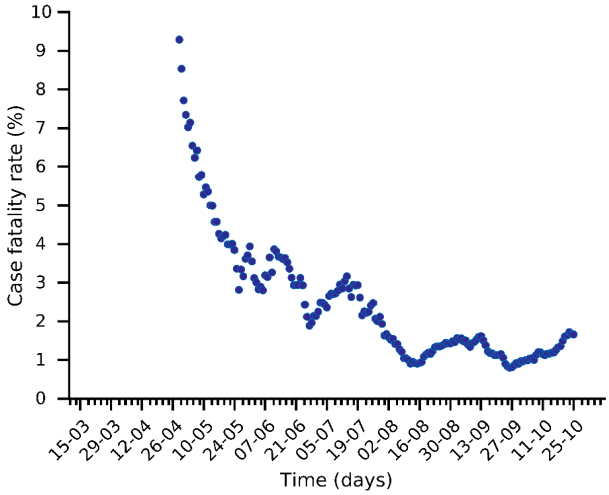
Current indicators

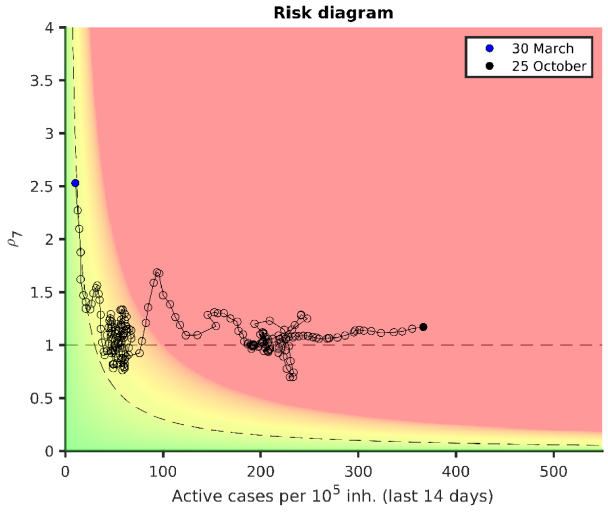
A_{14}	EPG	CFR
366	429	1.66 %

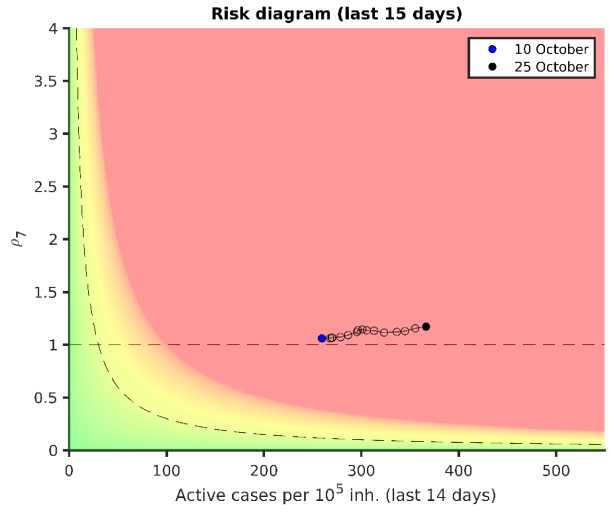




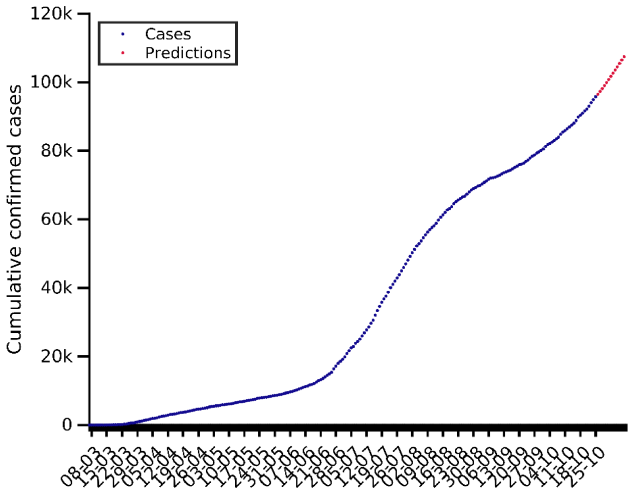








Nevada 25-10-2020. Pop: 3.1M. Cumulative incidence: 3110/10⁵

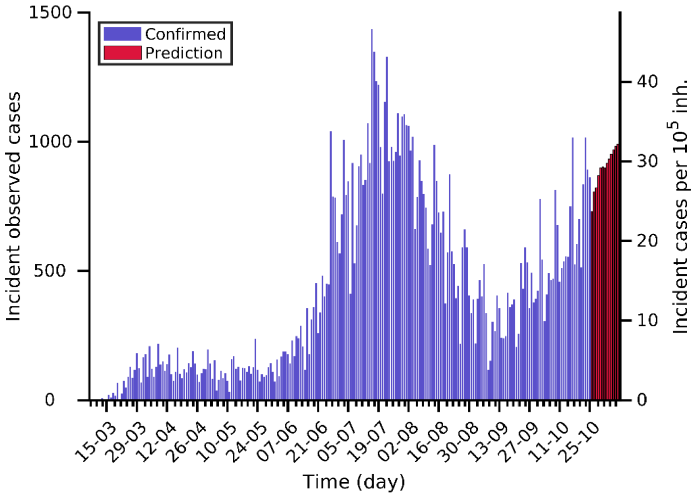


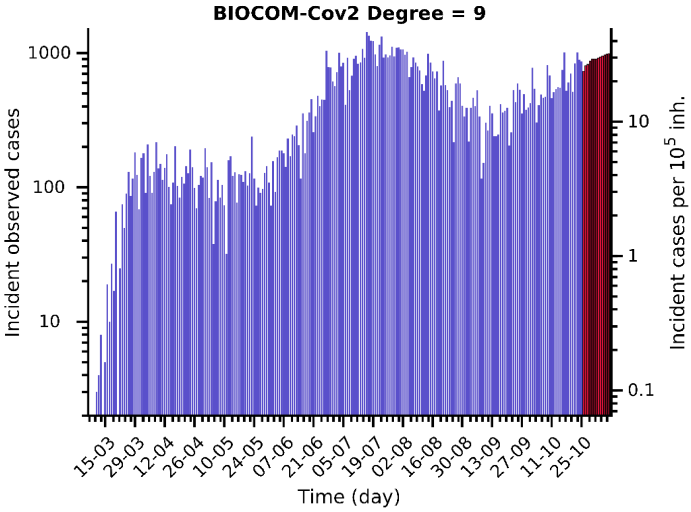
Predictions for next days

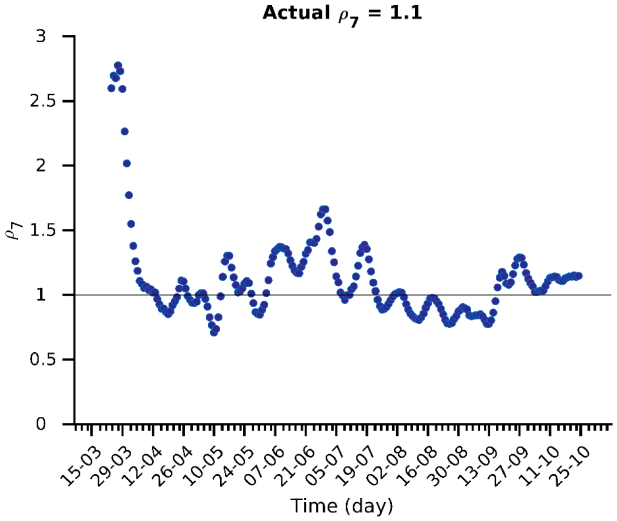
Day	Number of cases
26-10-2020	96528 (+730)
28-10-2020	98156 (+822)
30-10-2020	99924 (+899)

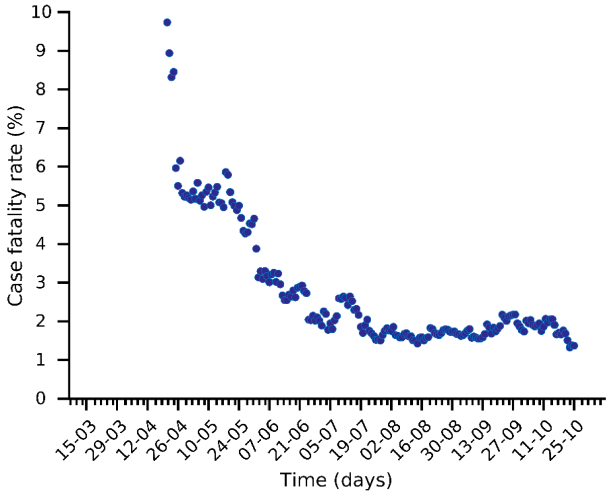
Current indicators

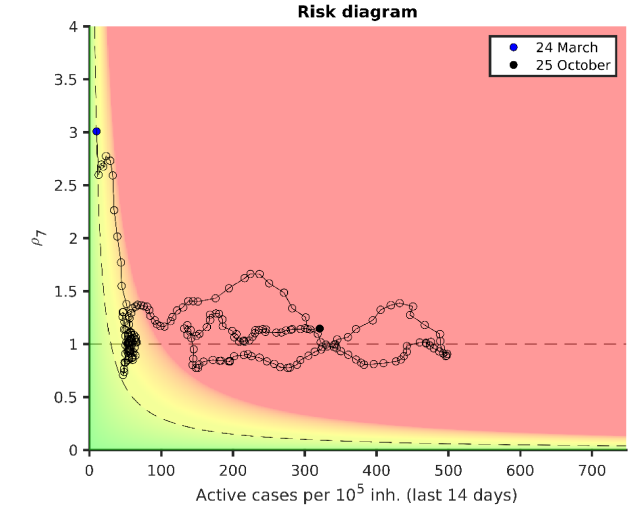
A_{14}	EPG	CFR
321	368	1.37 %

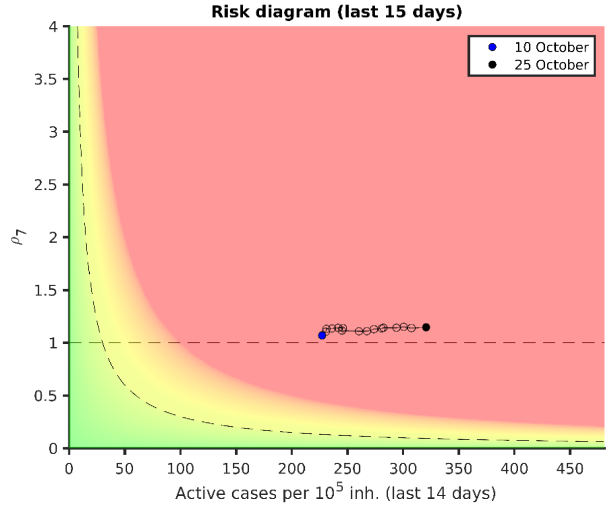




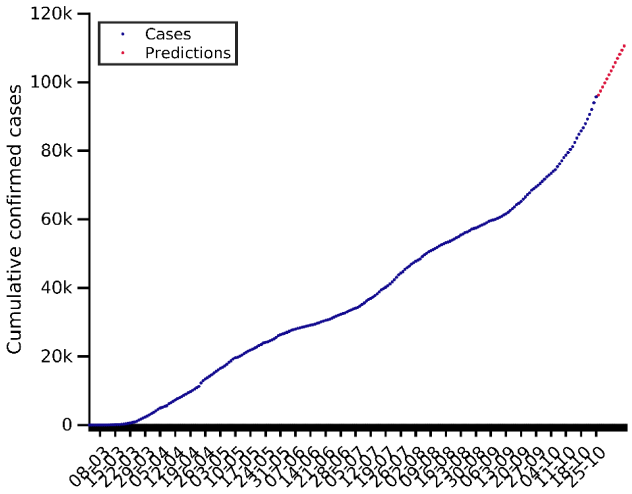








Colorado 25-10-2020. Pop: 5.8M. Cumulative incidence: 1663/10⁵

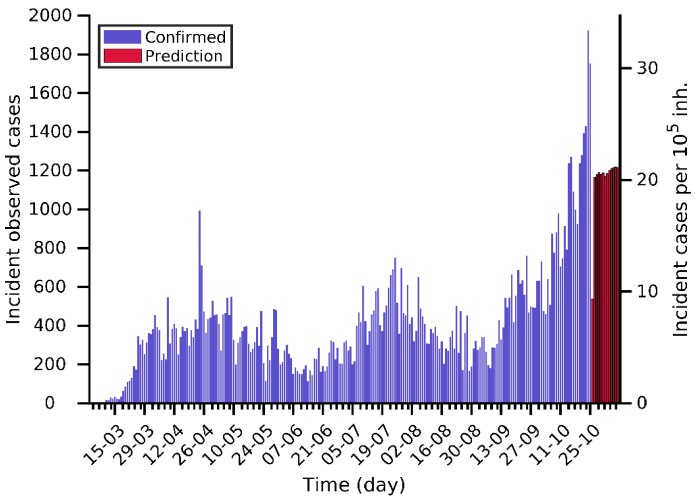


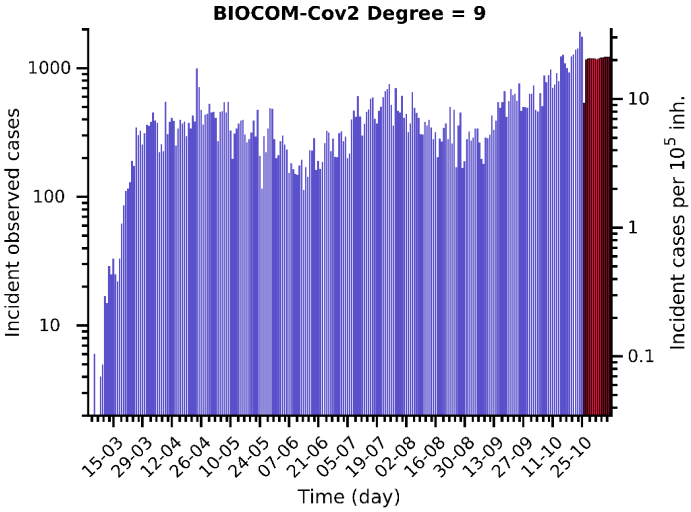
Predictions for next days

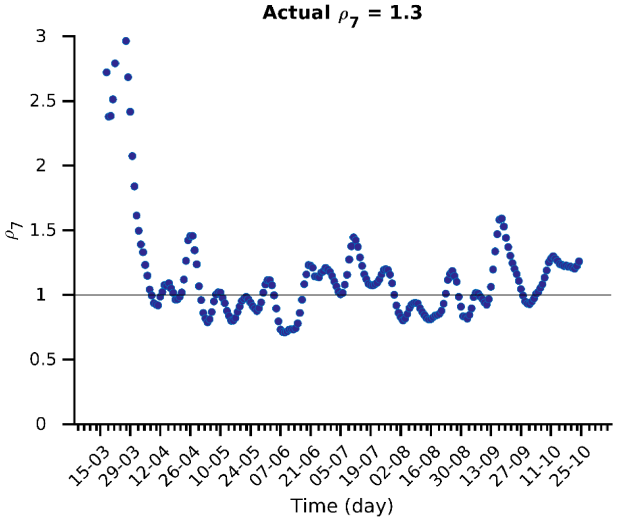
Day	Number of cases
26-10-2020	96279 (+537)
28-10-2020	98627 (+1180)
30-10-2020	100998 (+1182)

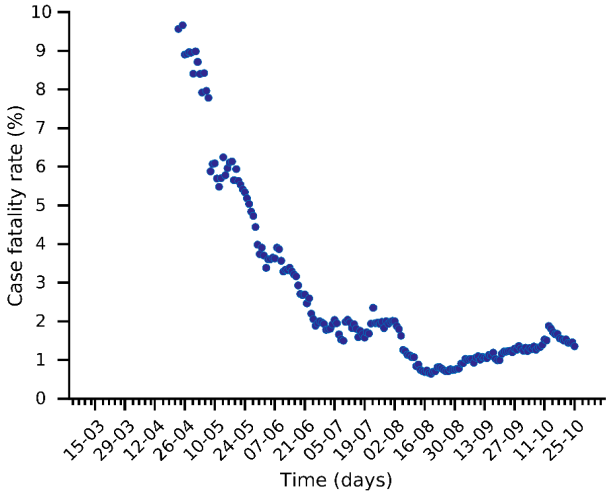
Current indicators

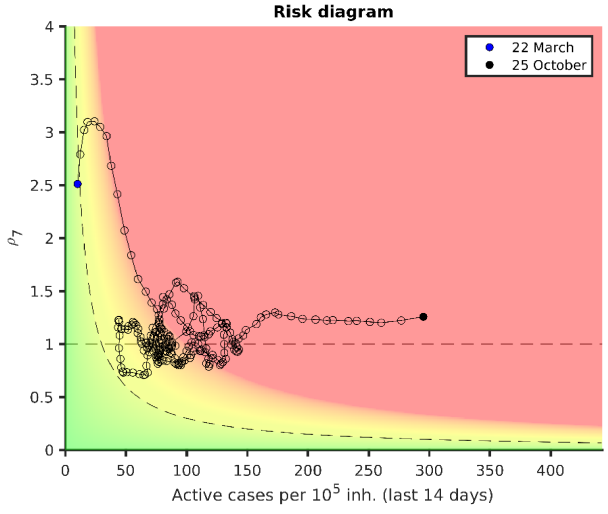
A_{14}	EPG	CFR
295	371	1.35 %

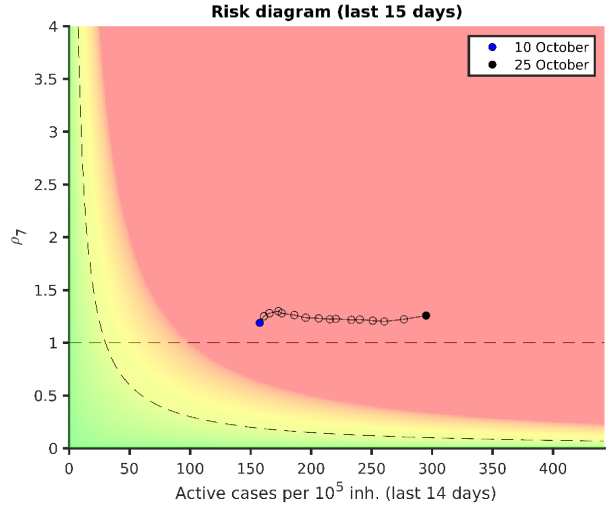




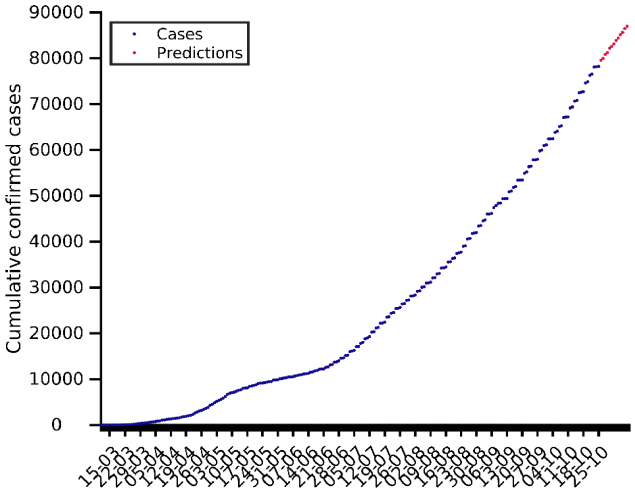








Kansas 25-10-2020. Pop: 2.9M. Cumulative incidence: 2686/10⁵

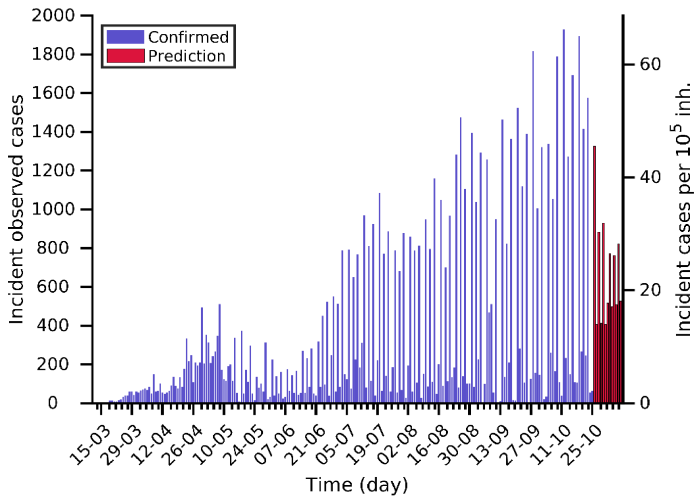


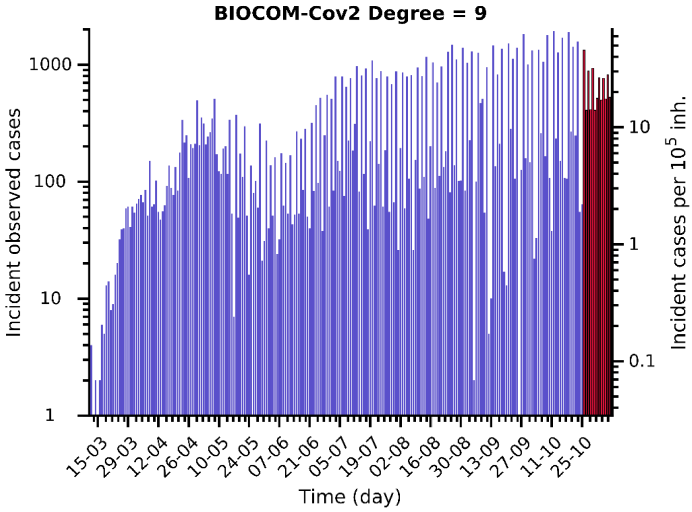
Predictions for next days

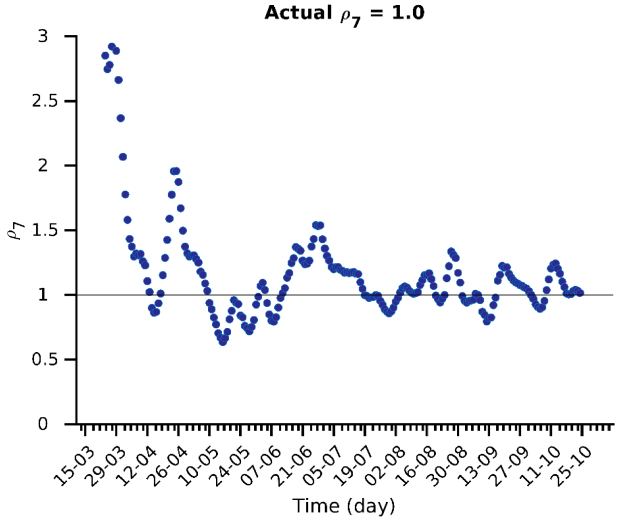
Day	Number of cases
26-10-2020	79568 (+1327)
28-10-2020	80856 (+882)
30-10-2020	82198 (+929)

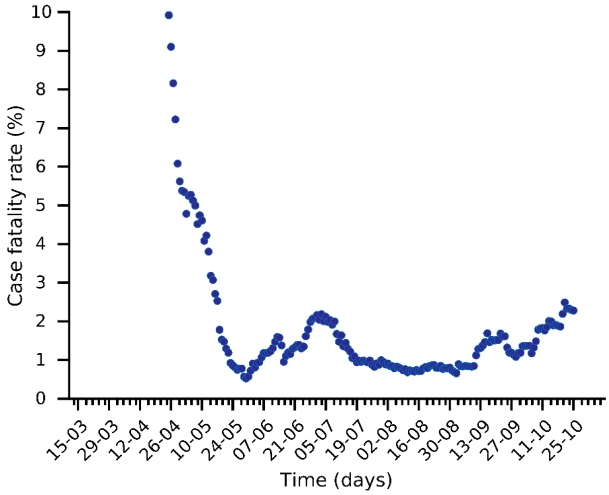
Current indicators

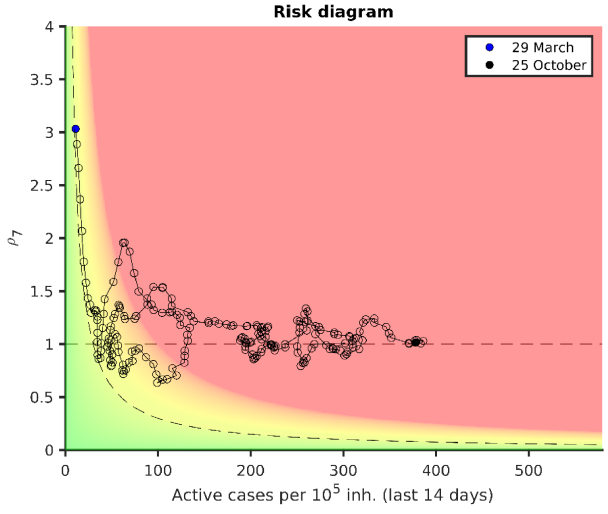
A_{14}	EPG	CFR
378	384	2.28 %

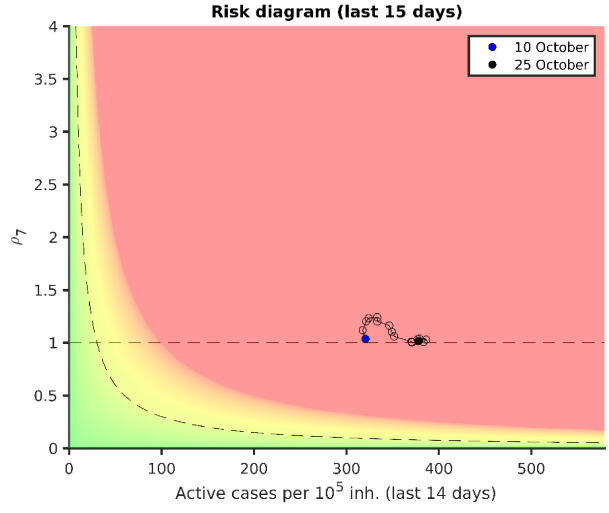




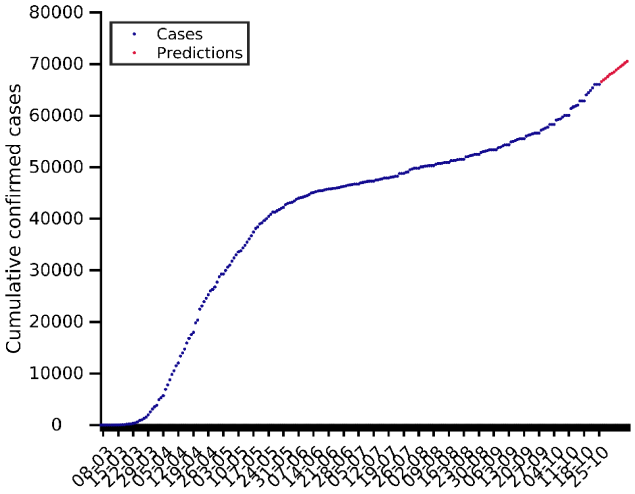








Connecticut 25-10-2020. Pop: 3.6M. Cumulative incidence: 1853/10^5

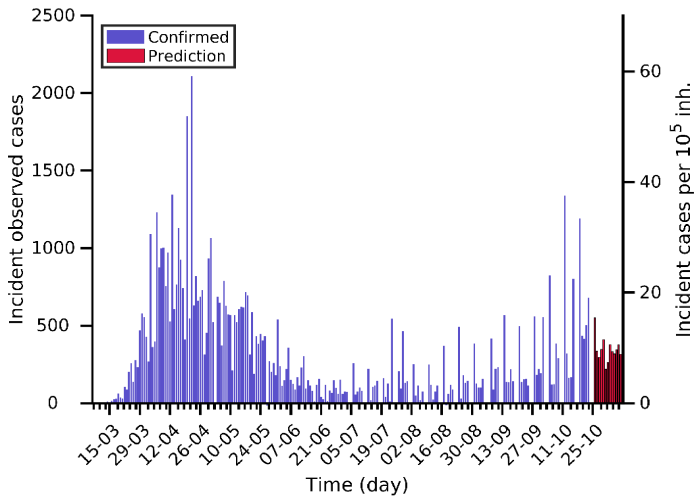


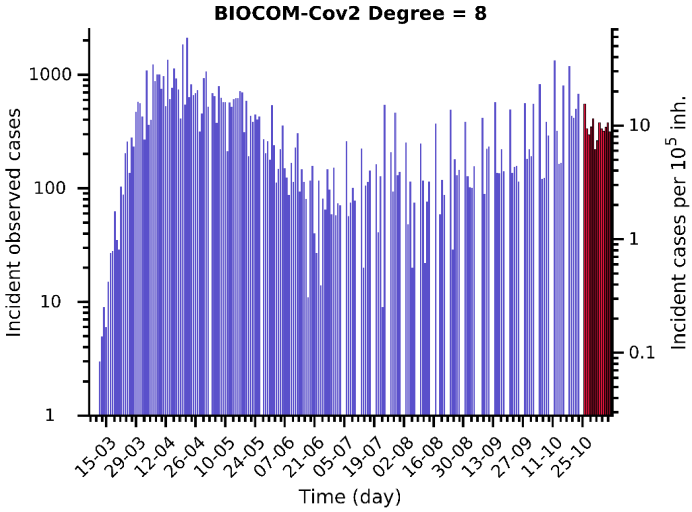
Predictions for next days

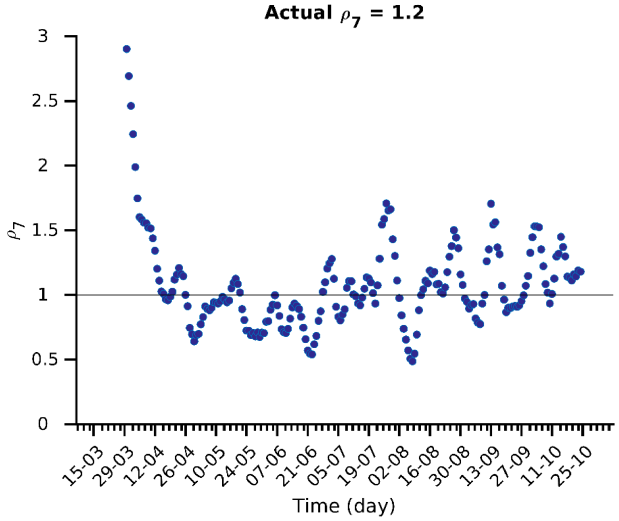
Day	Number of cases
26-10-2020	66602 (+550)
28-10-2020	67232 (+296)
30-10-2020	67989 (+411)

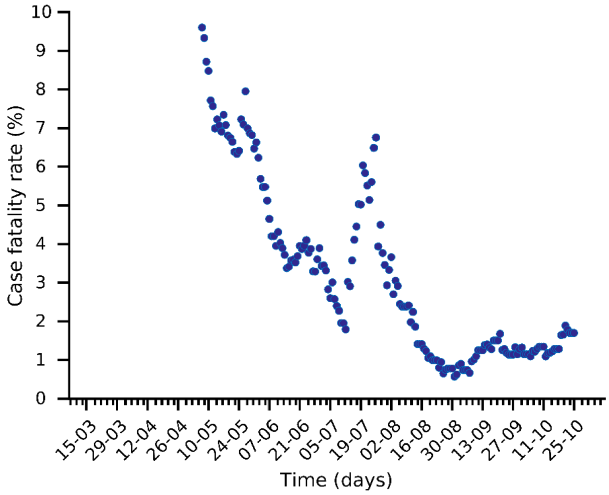
Current indicators

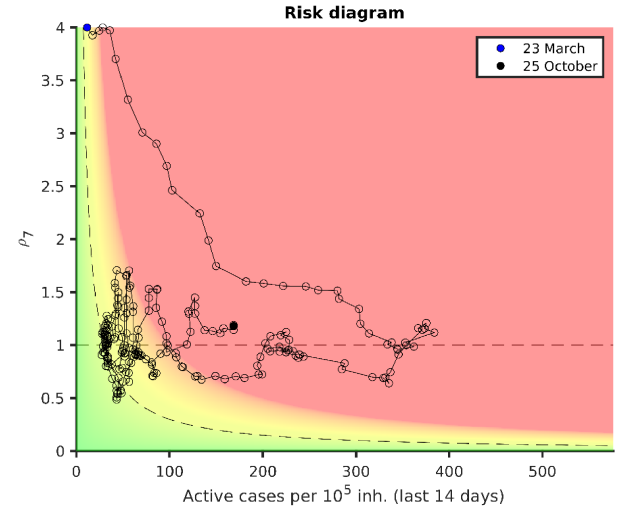
A_{14}	EPG	CFR
169	199	1.70 %

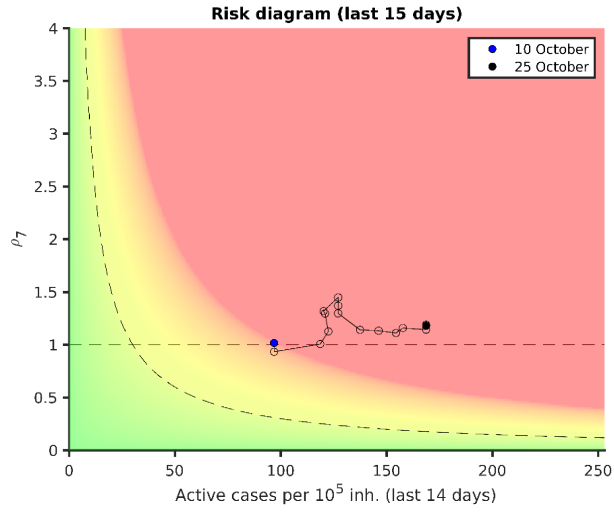




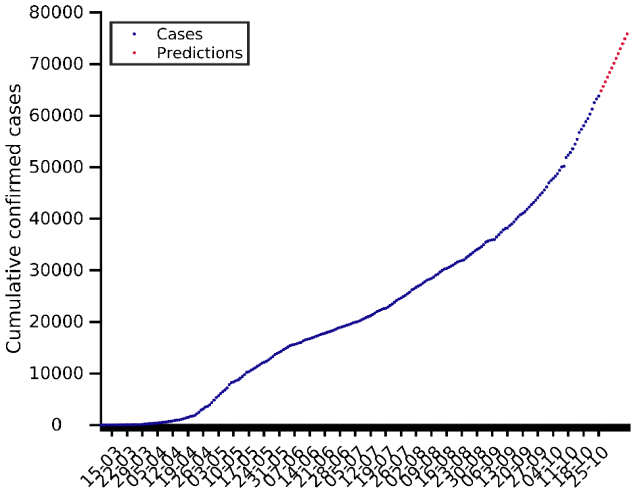








Nebraska 25-10-2020. Pop: 1.9M. Cumulative incidence: 3298/10^5

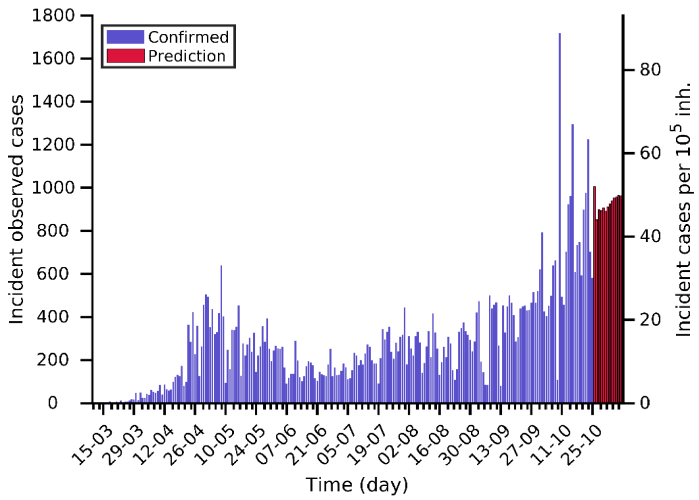


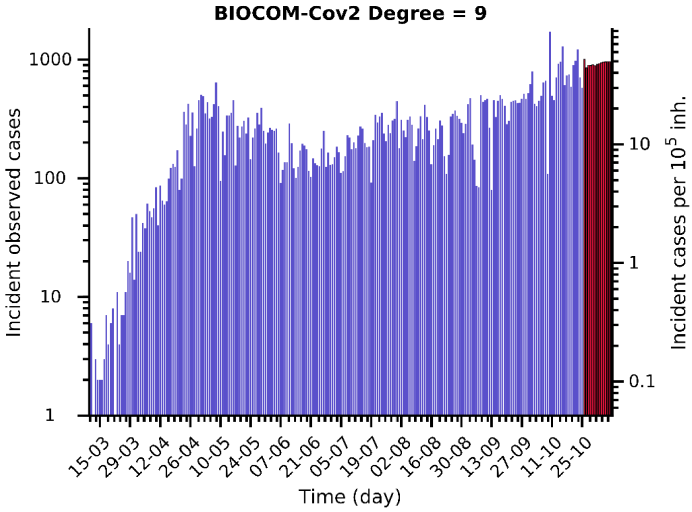
Predictions for next days

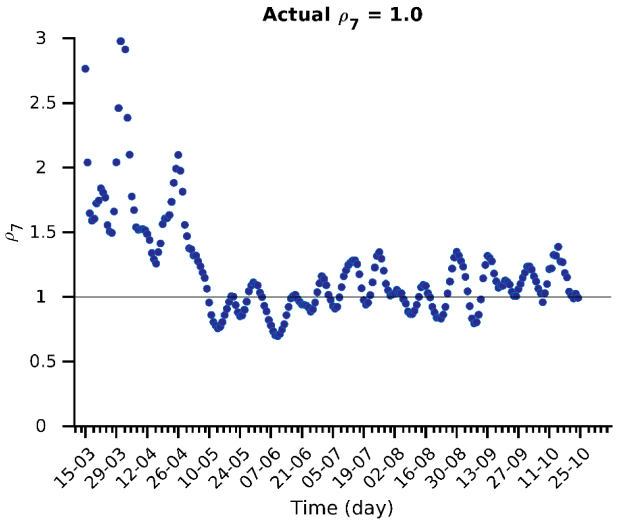
Day	Number of cases
26-10-2020	64802 (+1005)
28-10-2020	66554 (+900)
30-10-2020	68355 (+907)

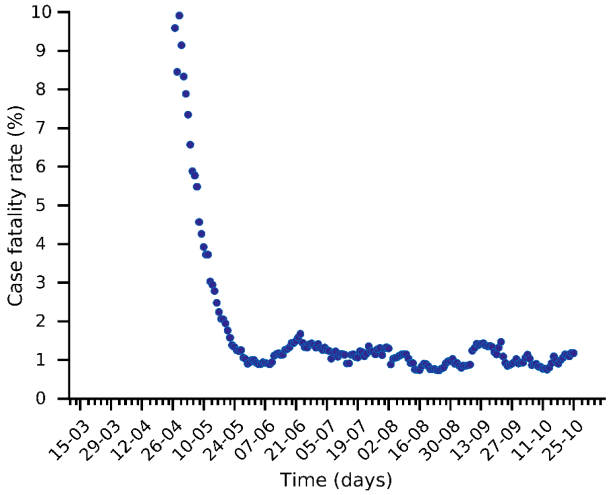
Current indicators

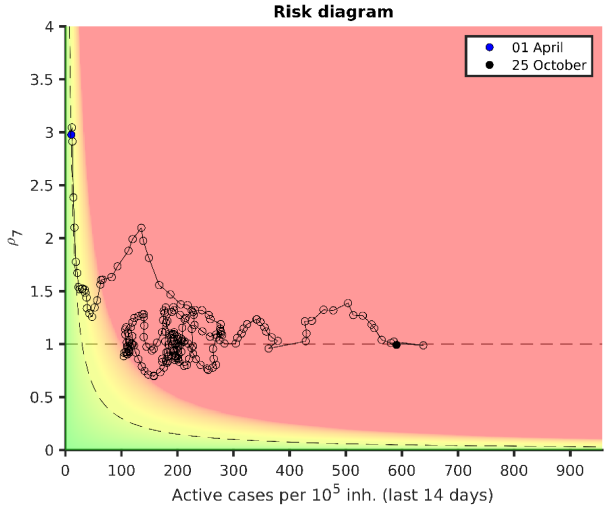
A_{14}	EPG	CFR
590	586	1.17 %

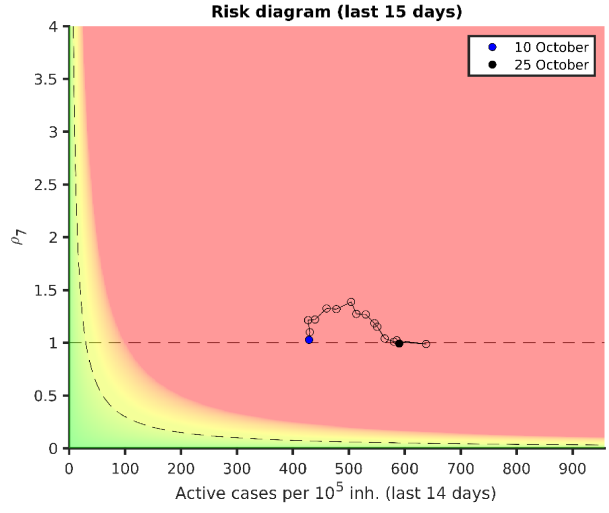




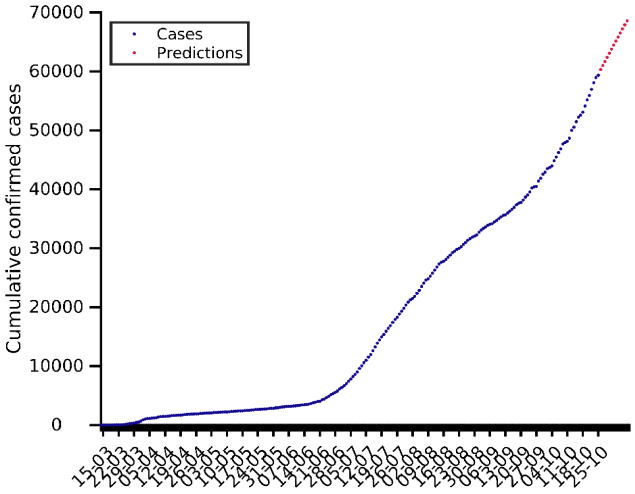








Idaho 25-10-2020. Pop: 1.8M. Cumulative incidence: 3321/10^5

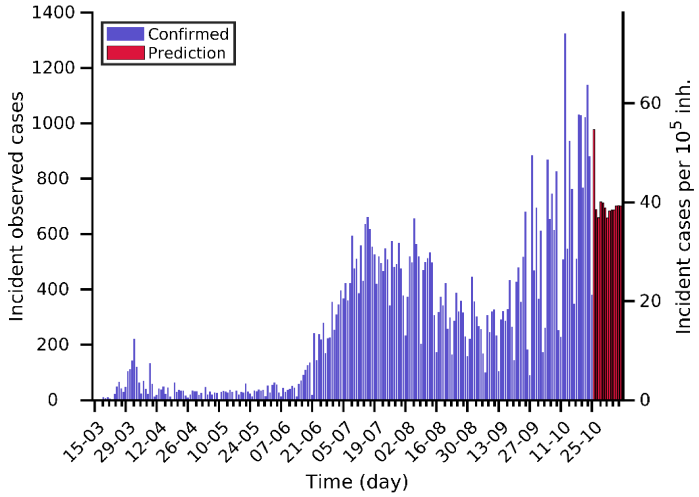


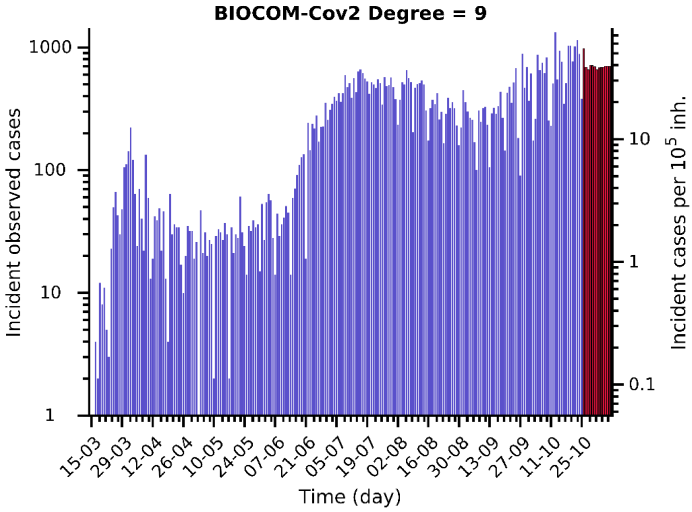
Predictions for next days

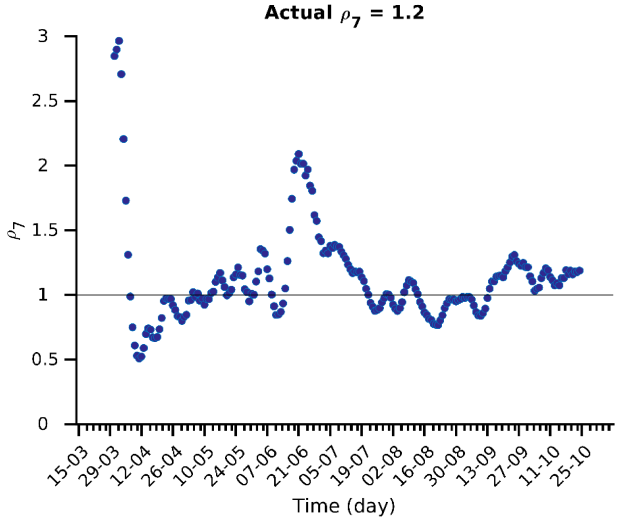
Day	Number of cases
26-10-2020	60321 (+977)
28-10-2020	61669 (+659)
30-10-2020	63098 (+712)

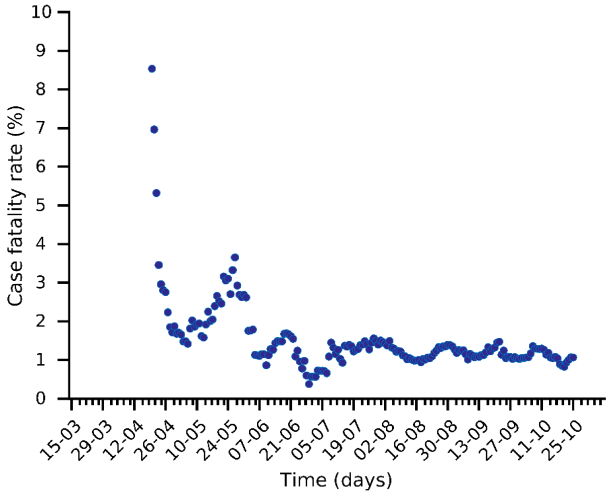
Current indicators

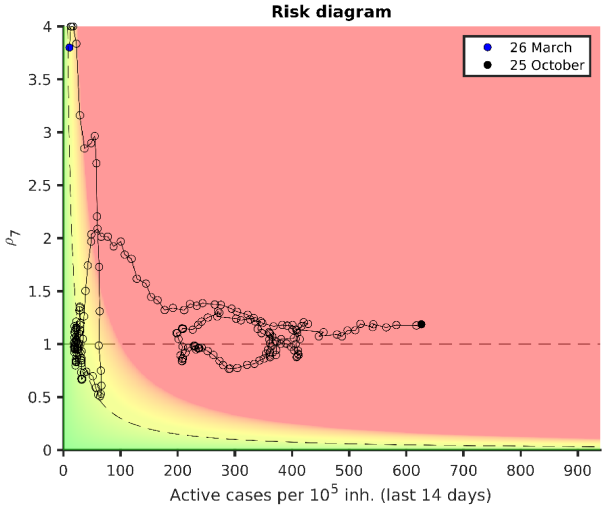
A_{14}	EPG	CFR
626	744	1.07 %

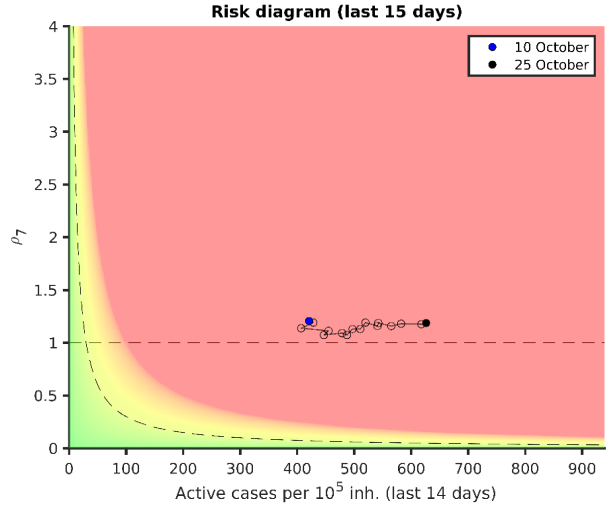




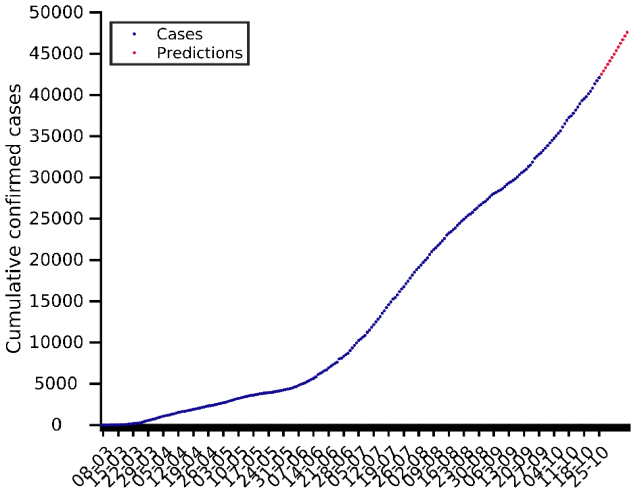








Oregon 25-10-2020. Pop: 4.2M. Cumulative incidence: 998/10⁵

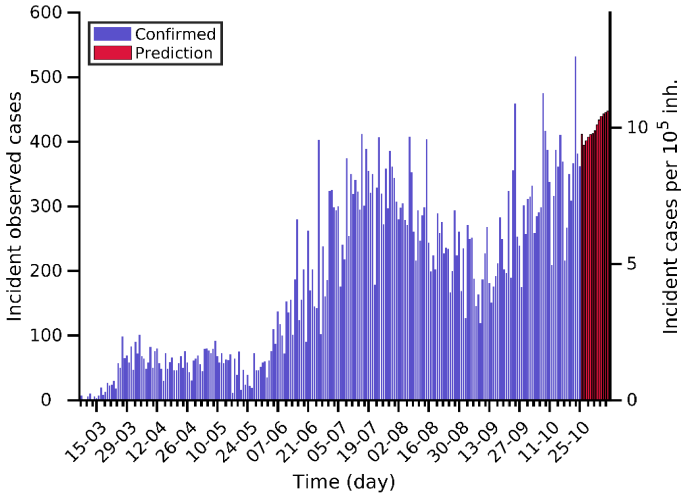


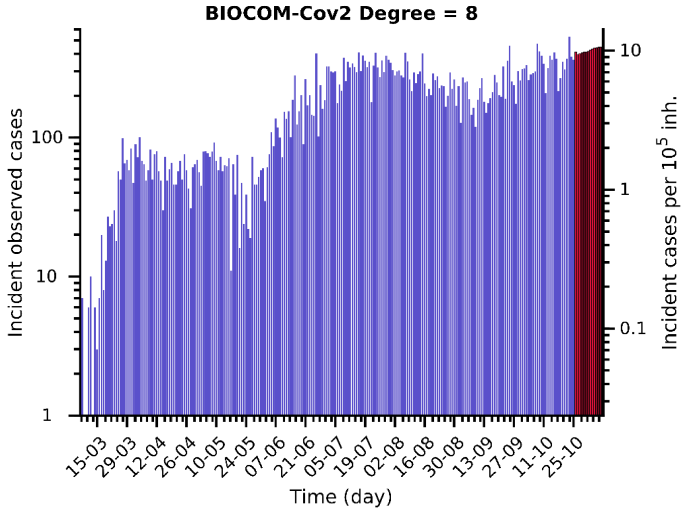
Predictions for next days

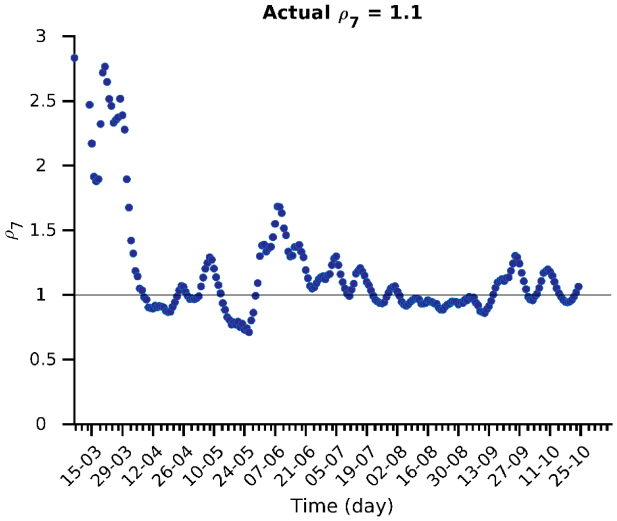
Day	Number of cases
26-10-2020	42513 (+412)
28-10-2020	43309 (+402)
30-10-2020	44128 (+411)

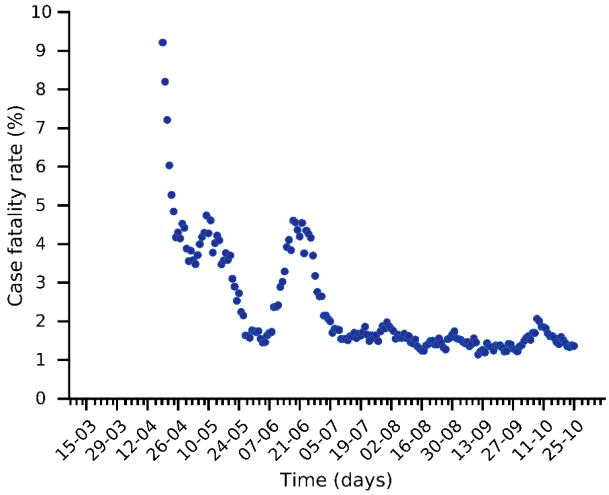
Current indicators

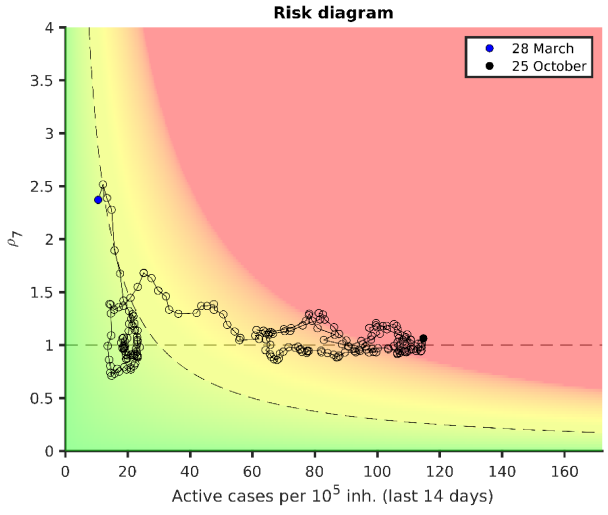
A_{14}	EPG	CFR
115	122	1.36 %

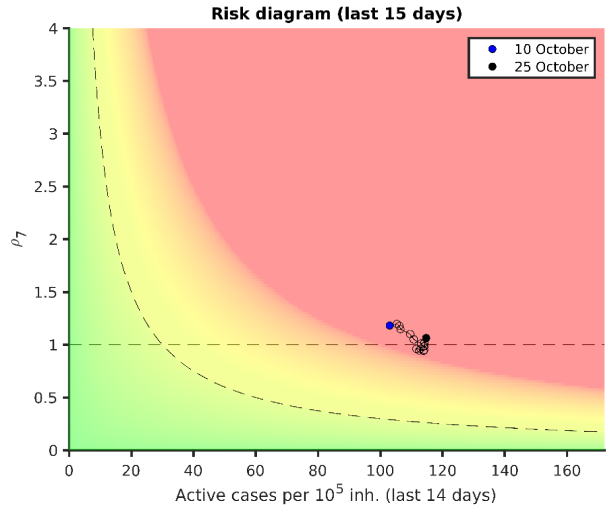




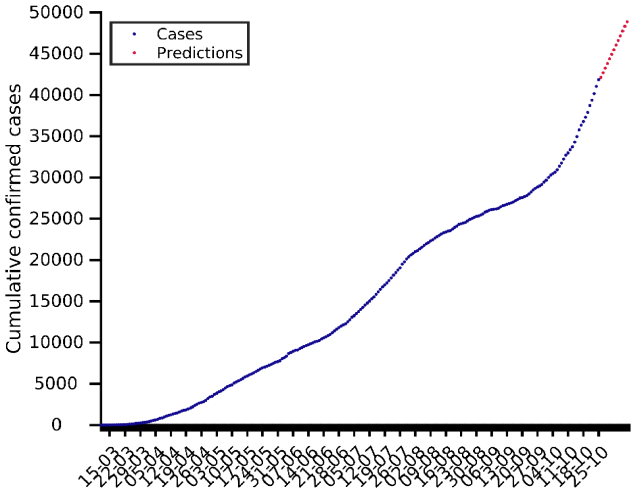








New Mexico 25-10-2020. Pop: 2.1M. Cumulative incidence: 1996/10^5

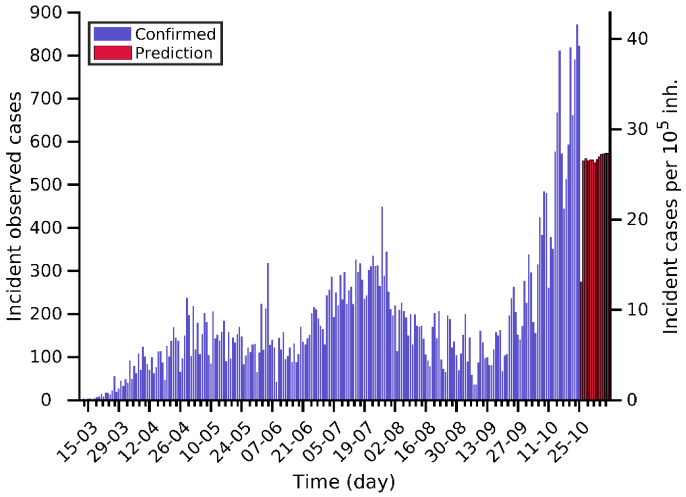


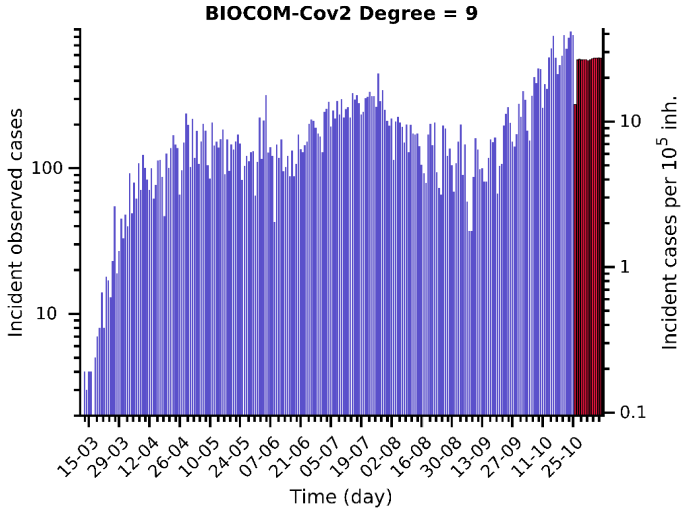
Predictions for next days

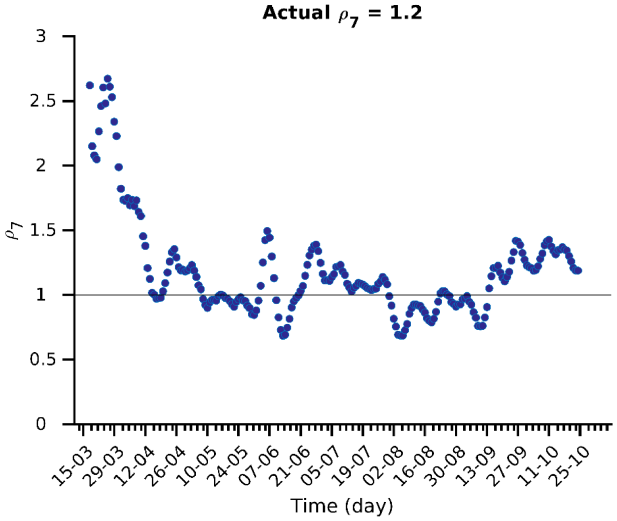
Day	Number of cases
26-10-2020	42137 (+274)
28-10-2020	43255 (+562)
30-10-2020	44370 (+558)

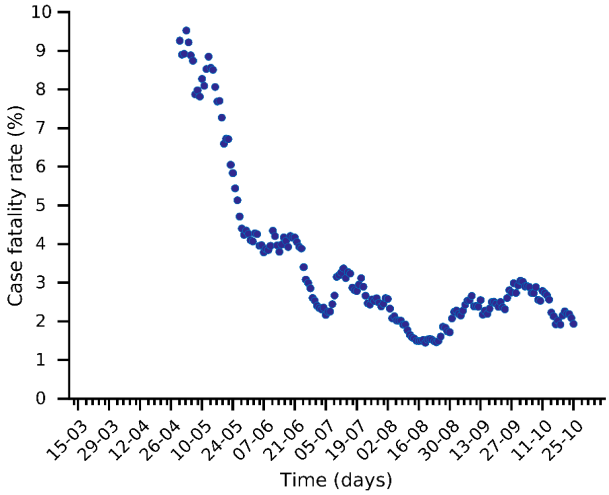
Current indicators

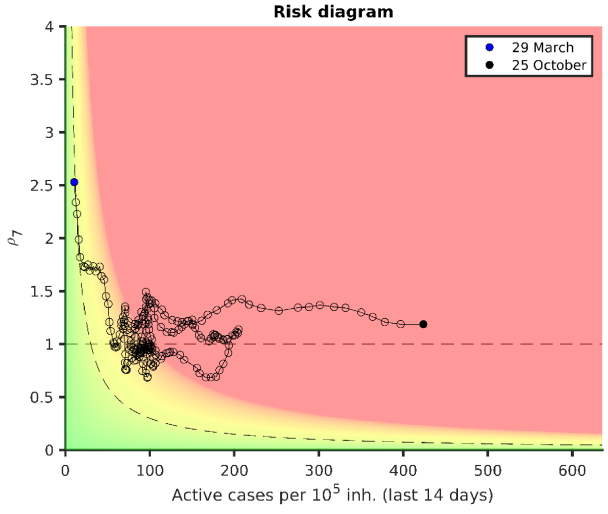
A_{14}	EPG	CFR
423	503	1.93 %

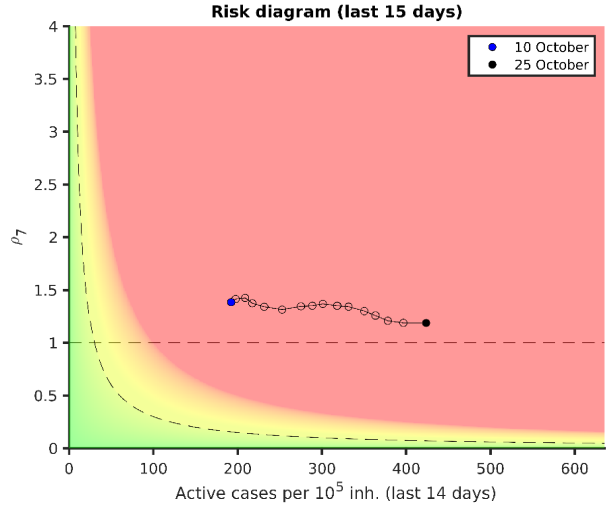




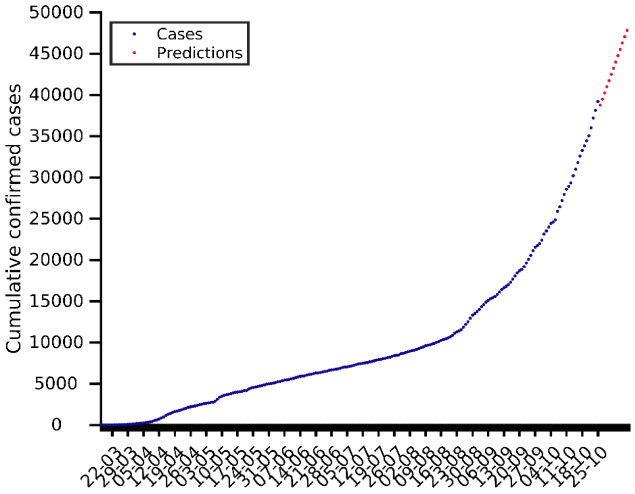








South Dakota 25-10-2020. Pop: 0.9M. Cumulative incidence: 4431/10^5

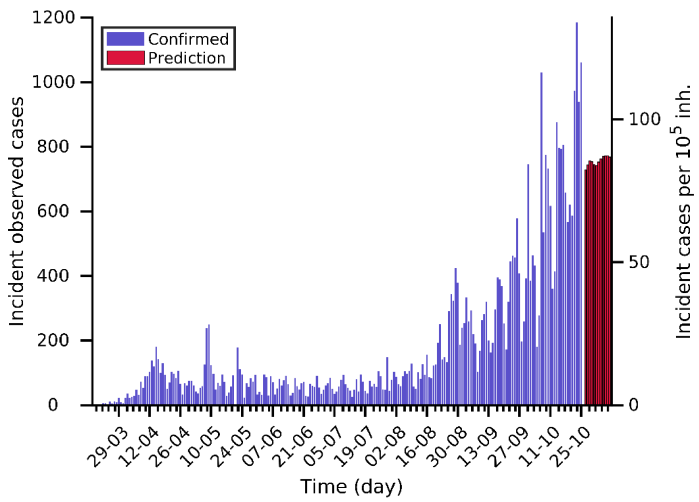


Predictions for next days

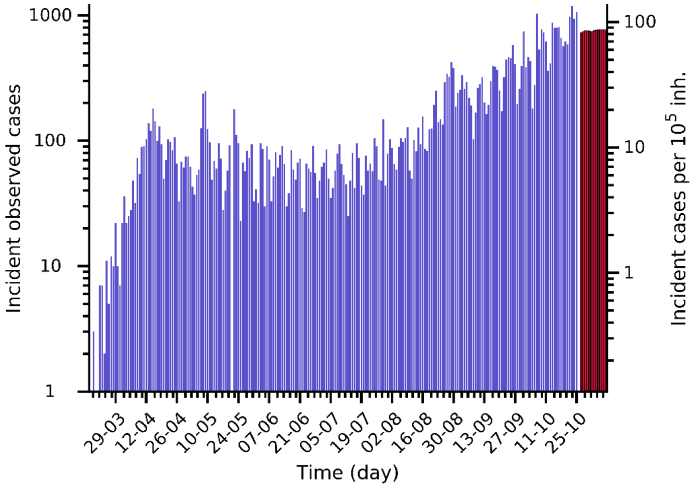
Day	Number of cases
26-10-2020	38768 (+-435)
28-10-2020	40240 (+744)
30-10-2020	41752 (+754)

Current indicators

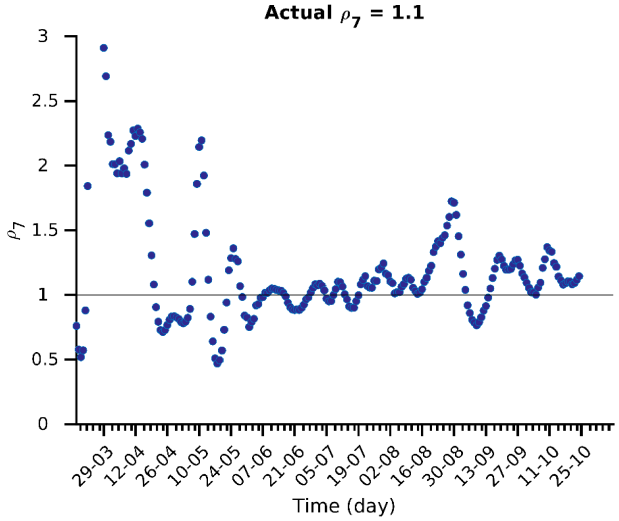
A_{14}	EPG	CFR
1203	1376	1.56 %

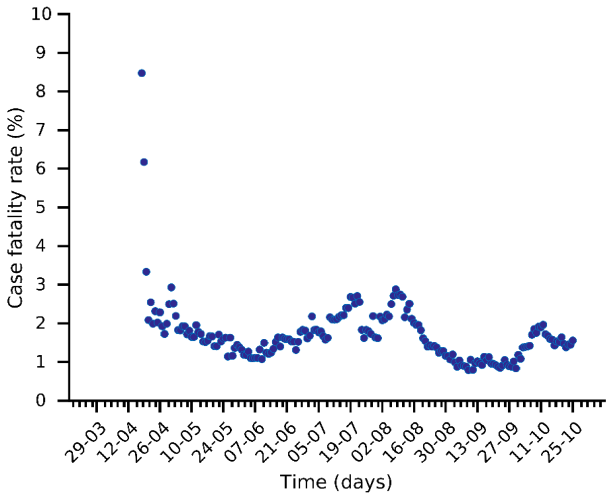


BIOCOM-Cov2 Degree = 9

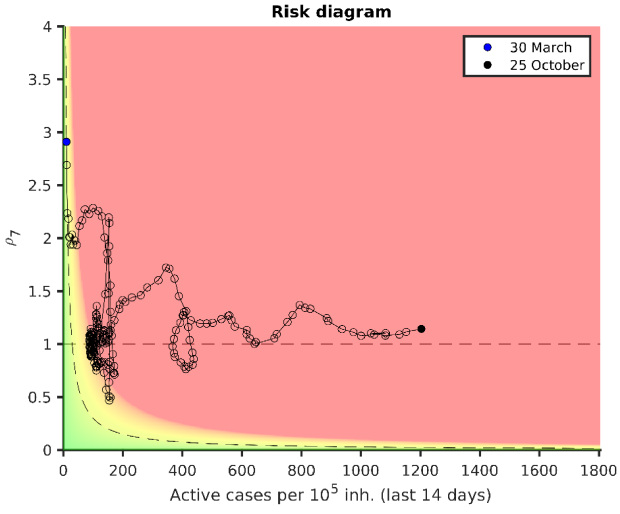


Actual ρ_7 = 1.1

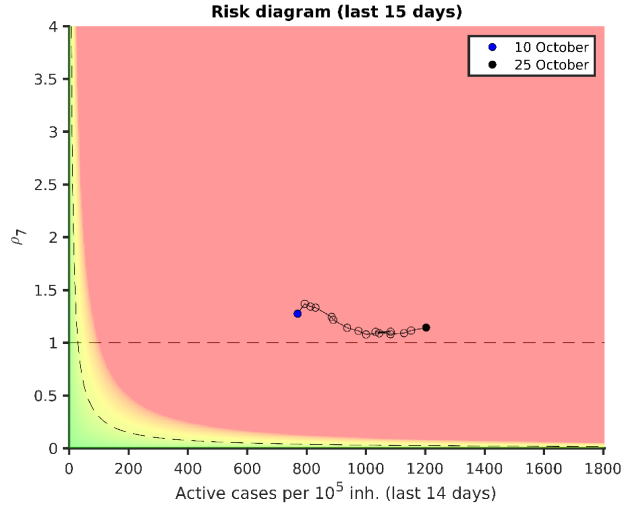




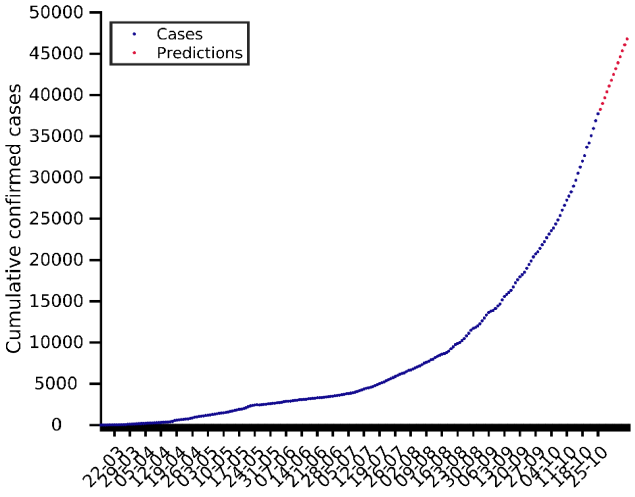
Risk diagram



Risk diagram (last 15 days)



North Dakota 25-10-2020. Pop: 0.8M. Cumulative incidence: 4950/10⁵

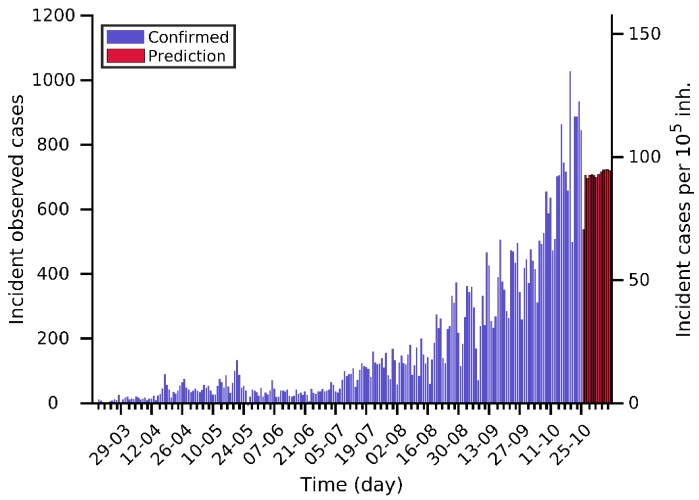


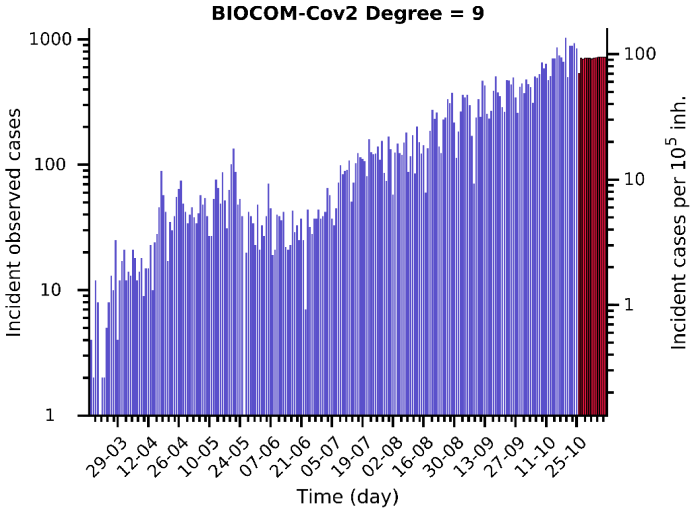
Predictions for next days

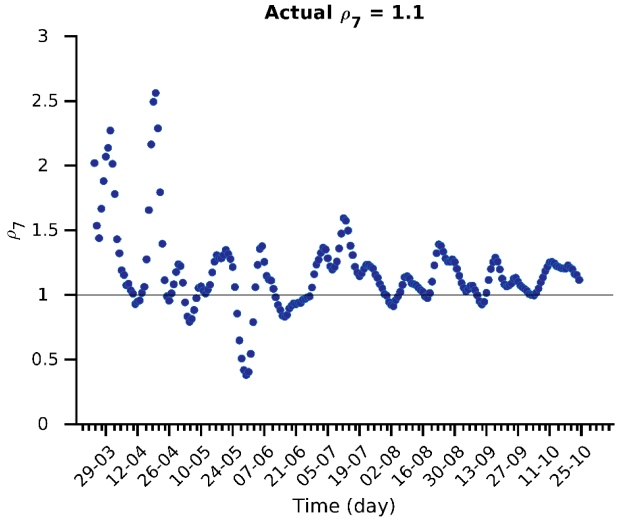
Day	Number of cases
26-10-2020	38261 (+537)
28-10-2020	39664 (+696)
30-10-2020	41077 (+707)

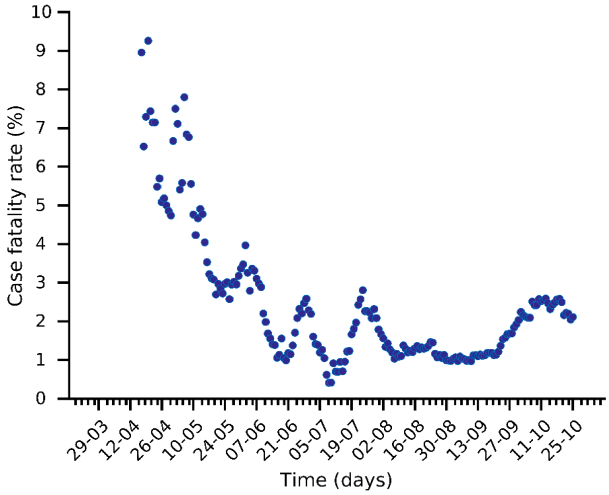
Current indicators

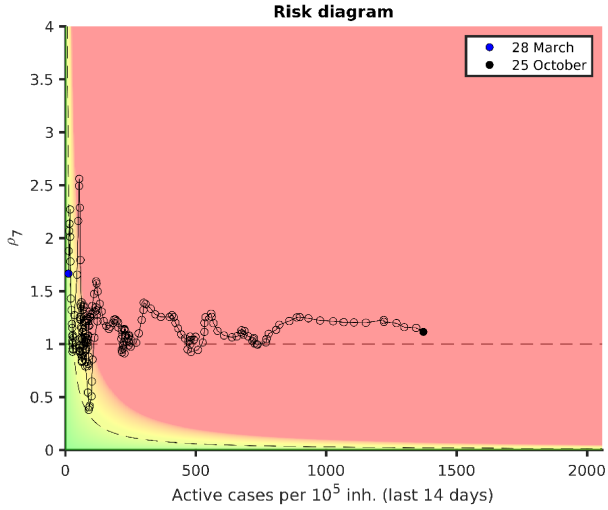
A_{14}	EPG	CFR
1372	1531	2.11 %

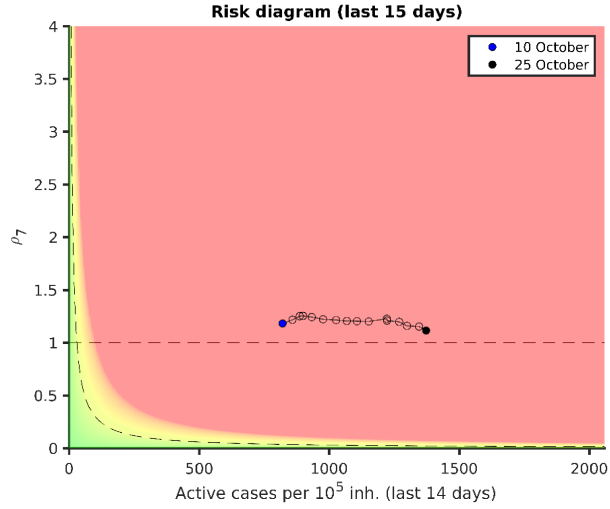




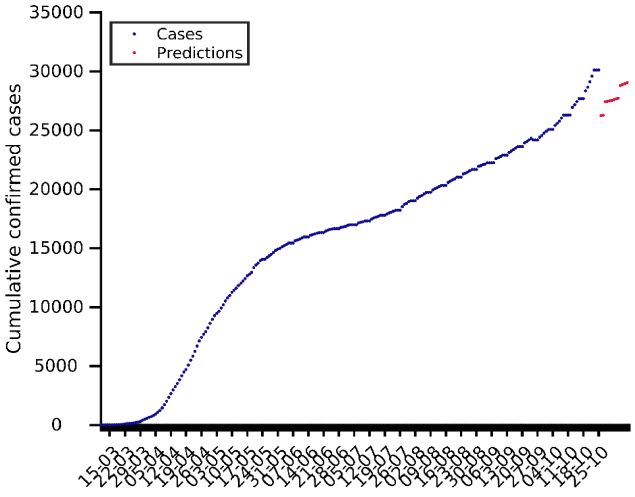








Rhode Island 25-10-2020. Pop: 1.1M. Cumulative incidence: 2843/10⁵

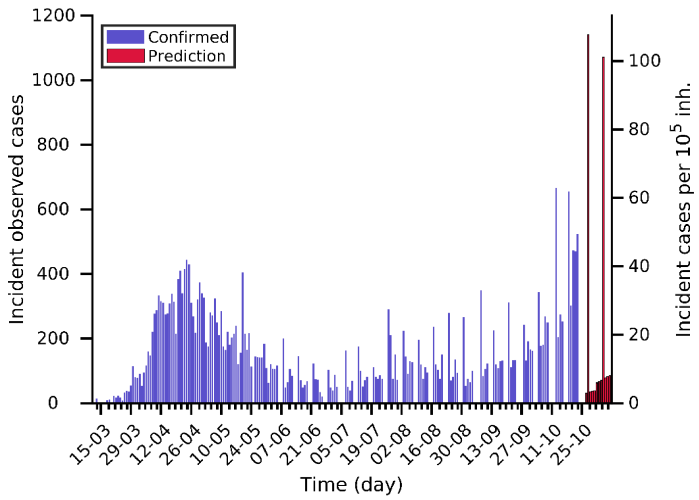


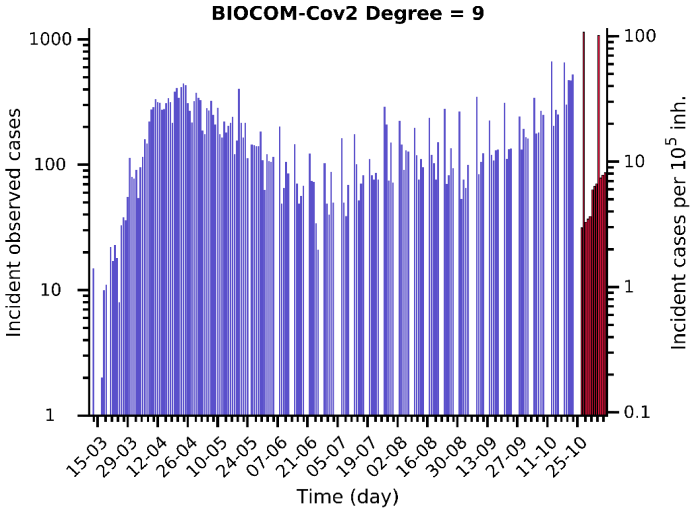
Predictions for next days

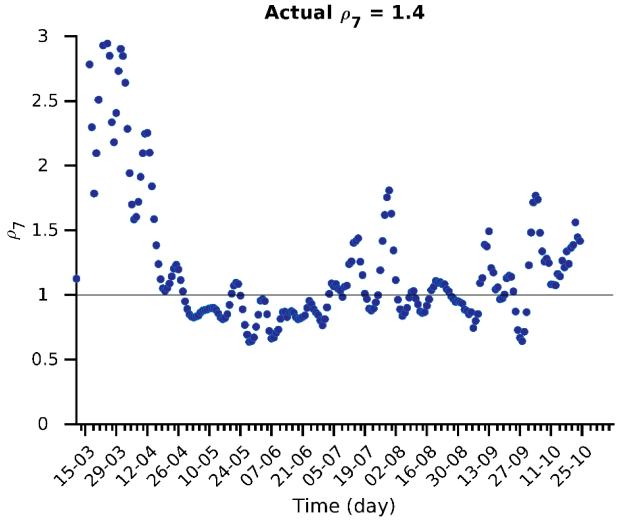
Day	Number of cases
26-10-2020	26252 (+-3866)
28-10-2020	27424 (+1141)
30-10-2020	27496 (+37)

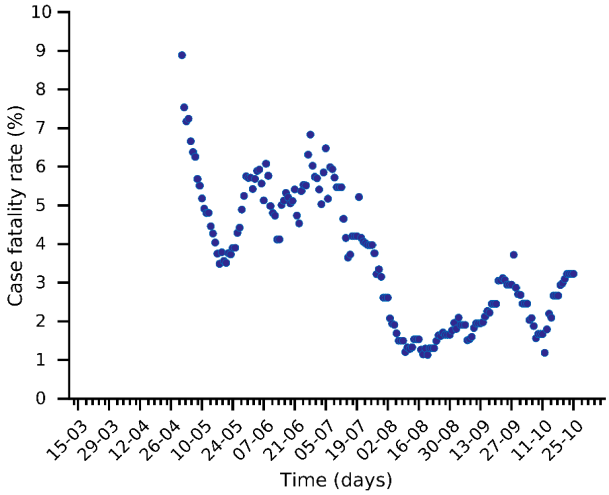
Current indicators

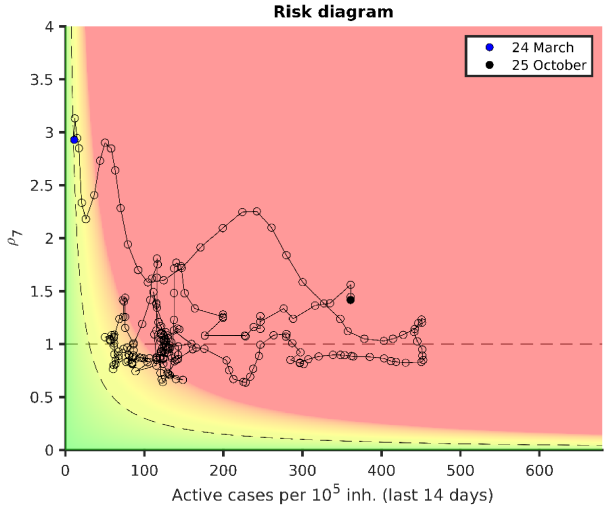
A_{14}	EPG	CFR
361	511	3.23 %

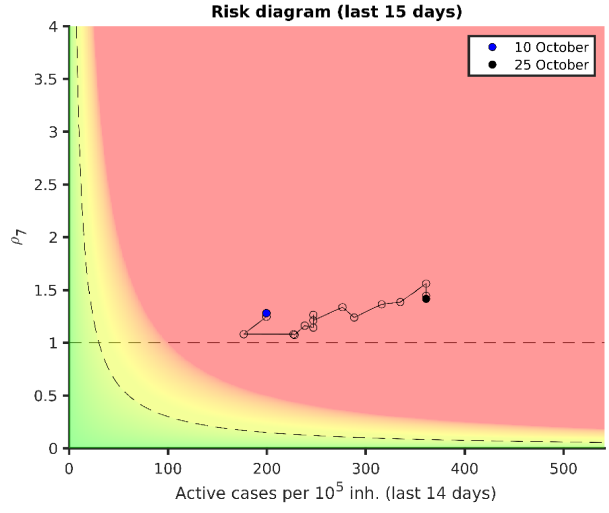




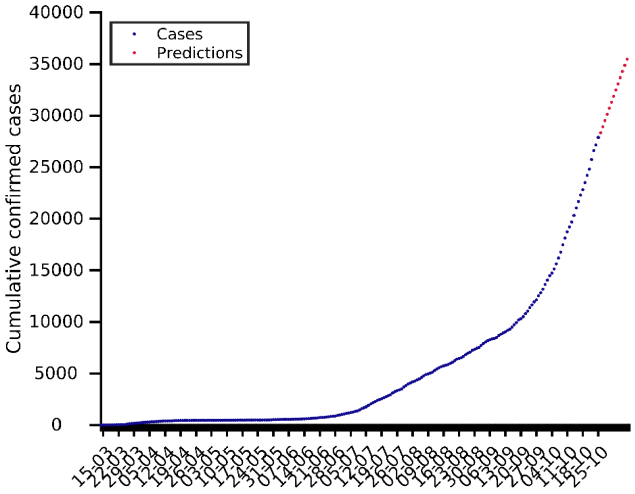








Montana 25-10-2020. Pop: 1.1M. Cumulative incidence: 2609/10⁵

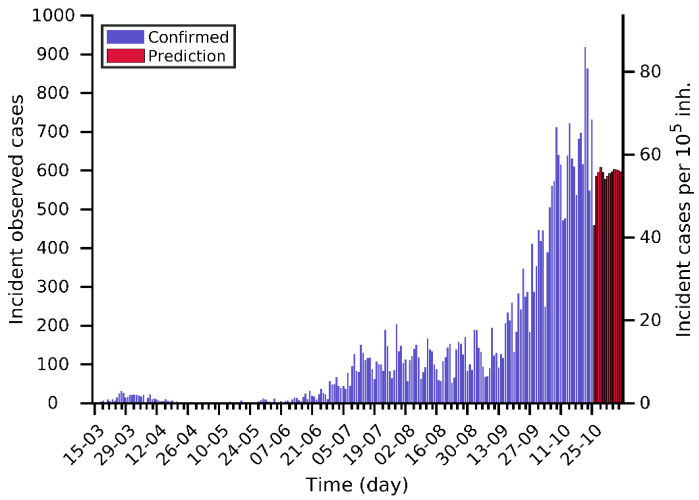


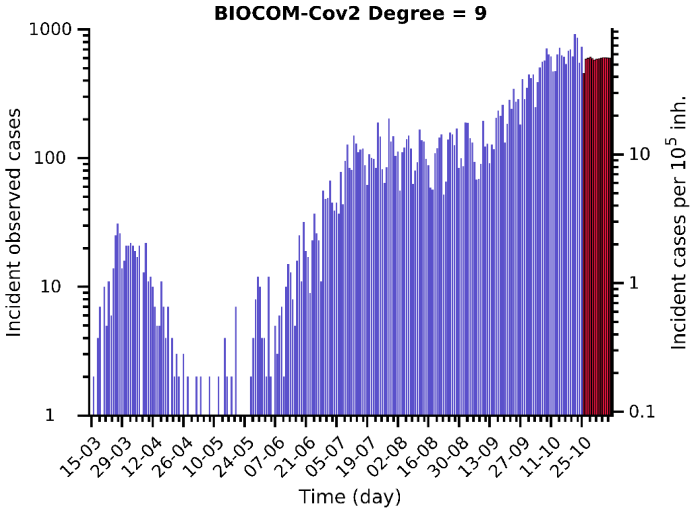
Predictions for next days

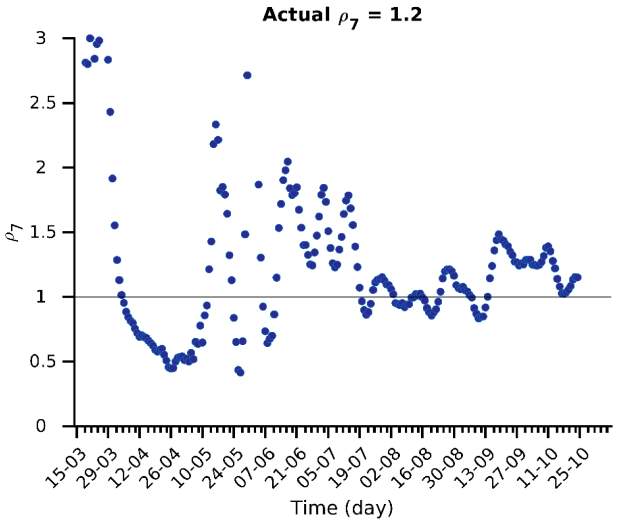
Day	Number of cases
26-10-2020	28337 (+457)
28-10-2020	29519 (+595)
30-10-2020	30721 (+594)

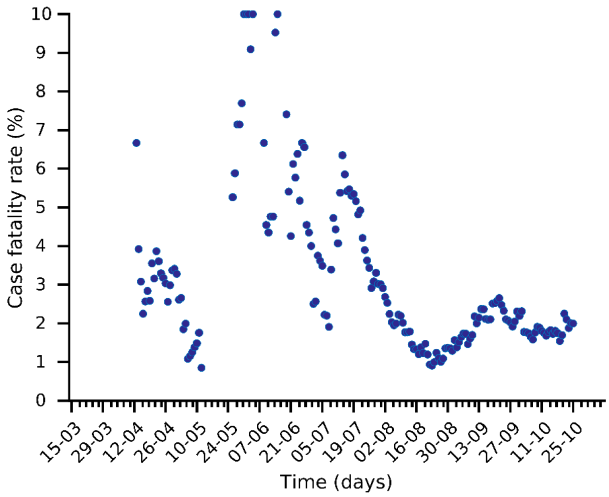
Current indicators

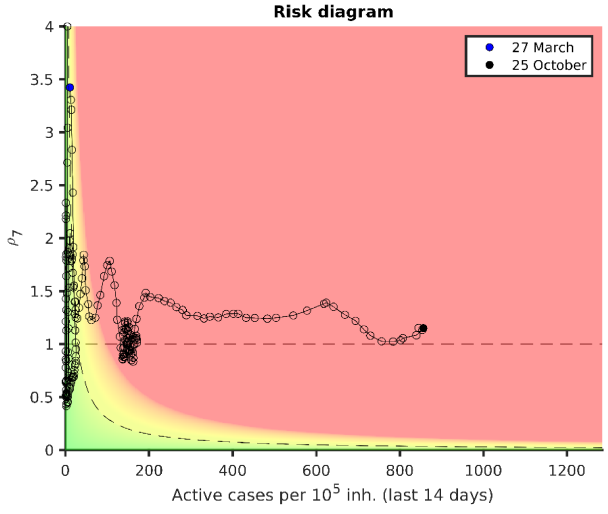
A_{14}	EPG	CFR
856	985	1.99 %

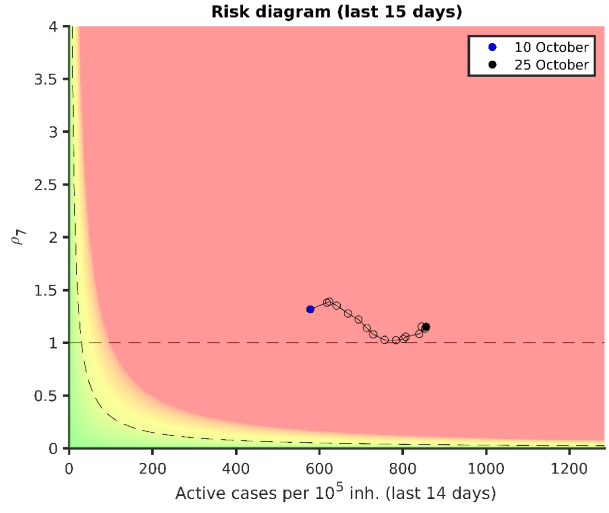




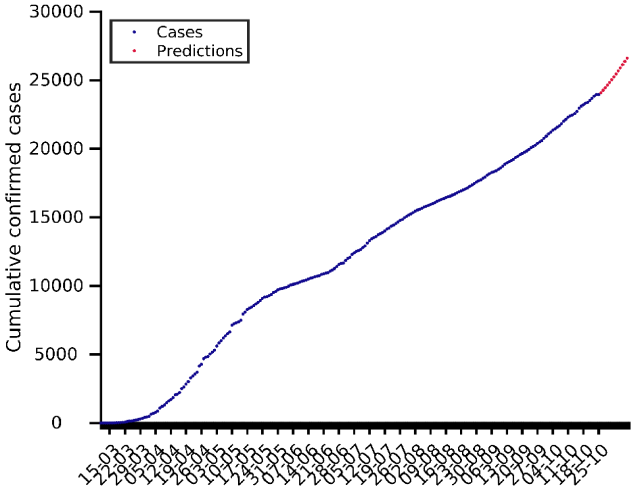








Delaware 25-10-2020. Pop: 1.0M. Cumulative incidence: 2461/10⁵

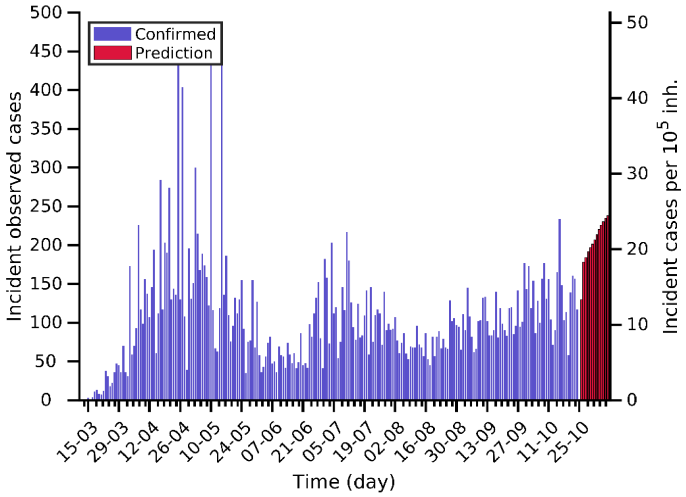


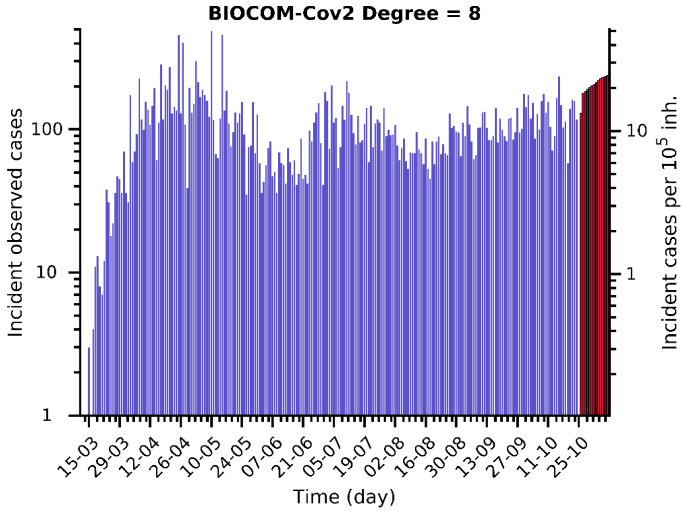
Predictions for next days

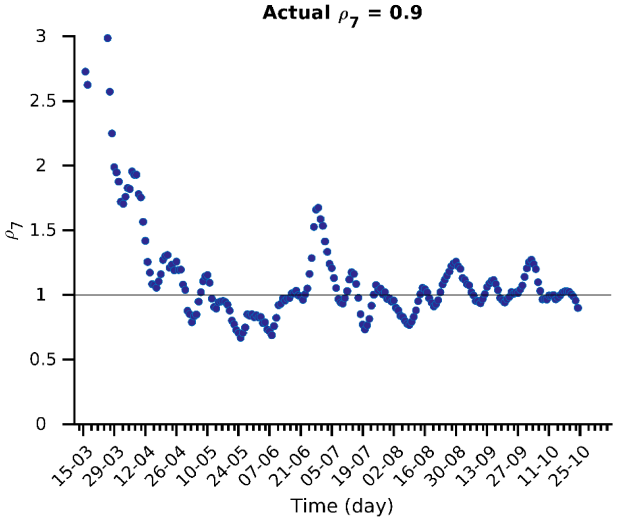
Day	Number of cases
26-10-2020	24091 (+130)
28-10-2020	24453 (+184)
30-10-2020	24842 (+197)

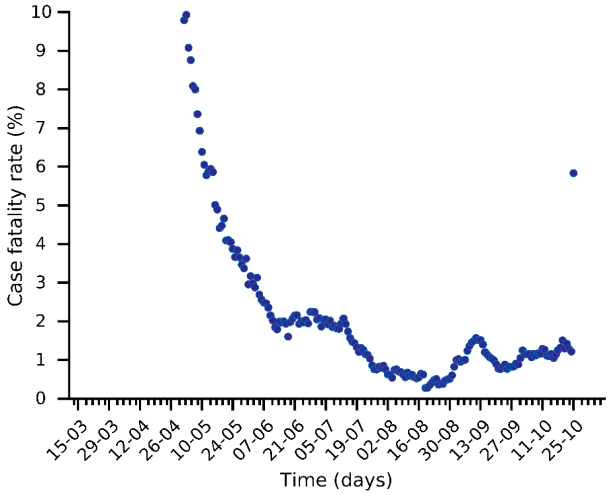
Current indicators

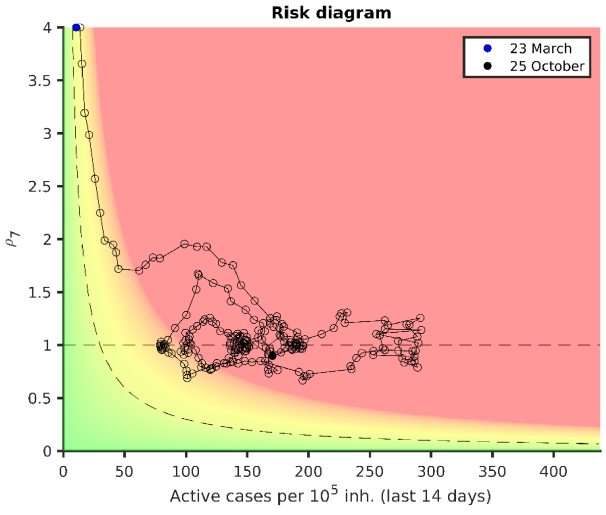
A_{14}	EPG	CFR
171	153	5.83 %

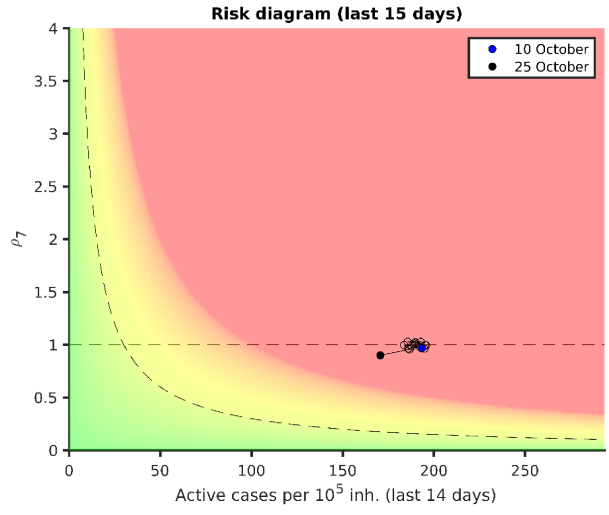




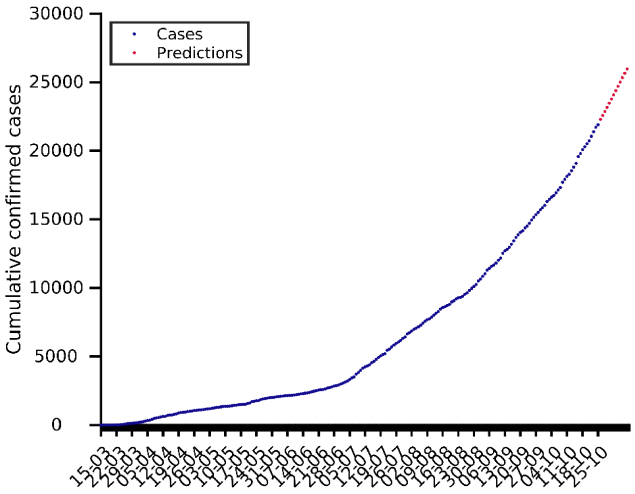








West Virginia 25-10-2020. Pop: 1.8M. Cumulative incidence: 1222/10⁵

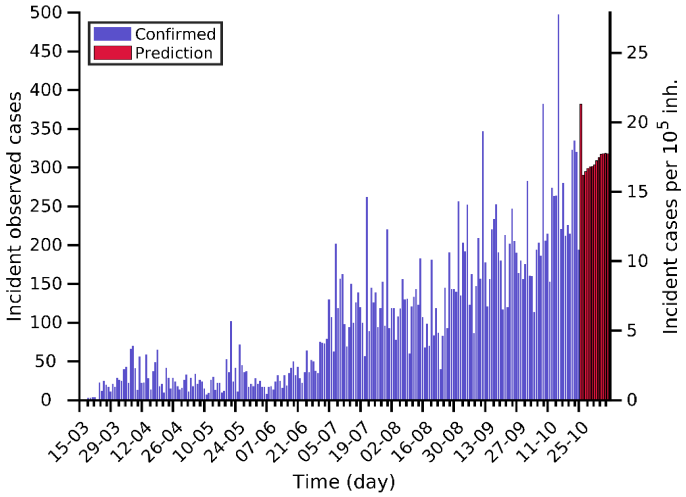


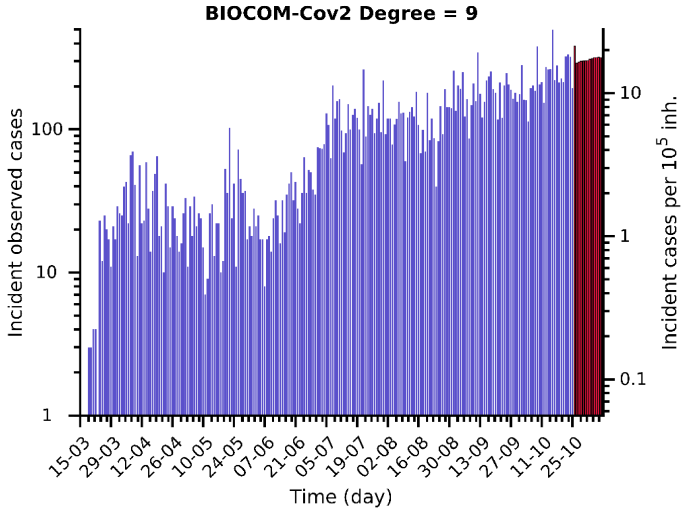
Predictions for next days

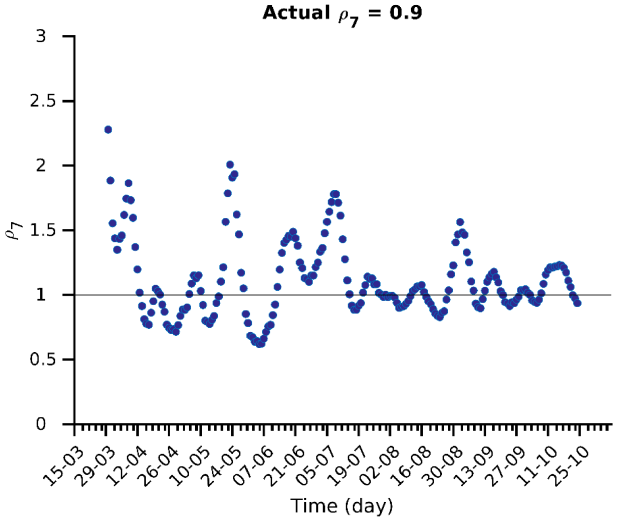
Day	Number of cases
26-10-2020	22288 (+382)
28-10-2020	22874 (+295)
30-10-2020	23473 (+301)

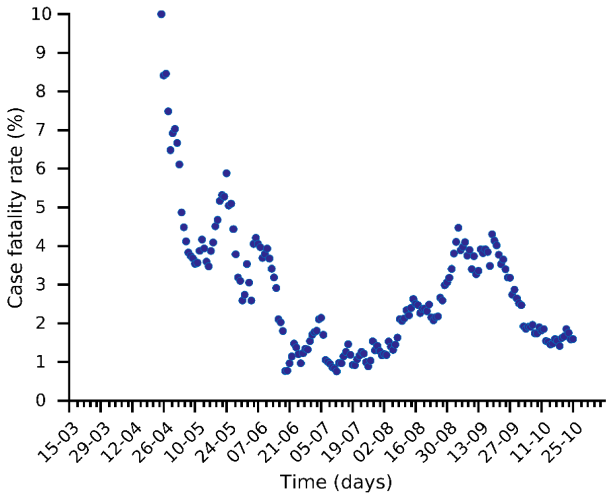
Current indicators

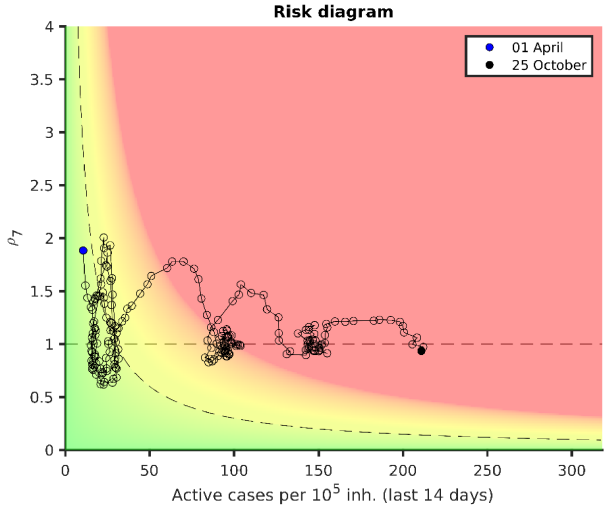
A_{14}	EPG	CFR
211	197	1.59 %

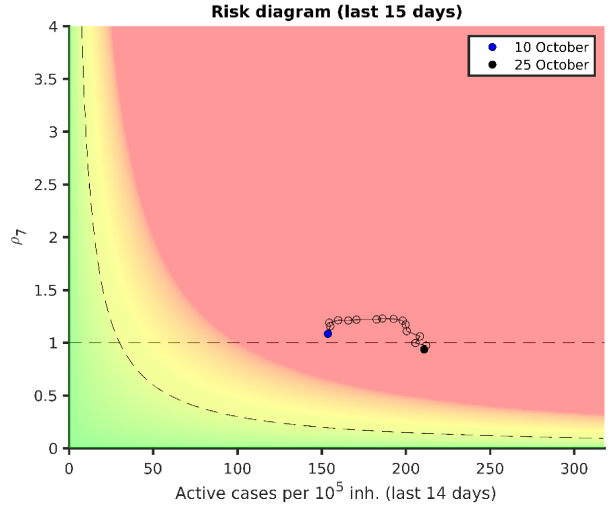




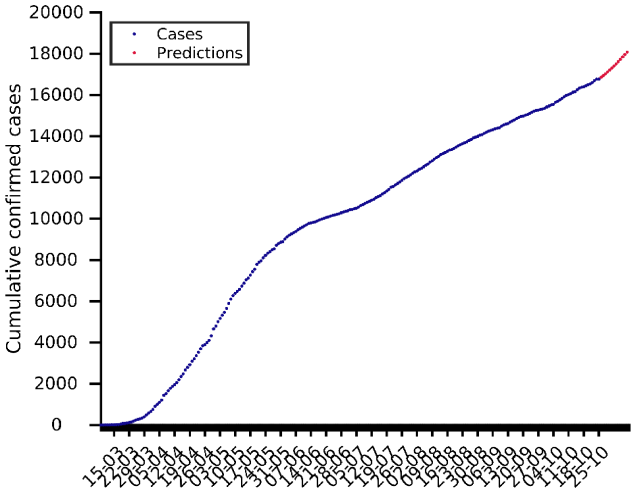








District of Columbia 25-10-2020. Pop: 0.7M. Cumulative incidence: 2376/10⁵

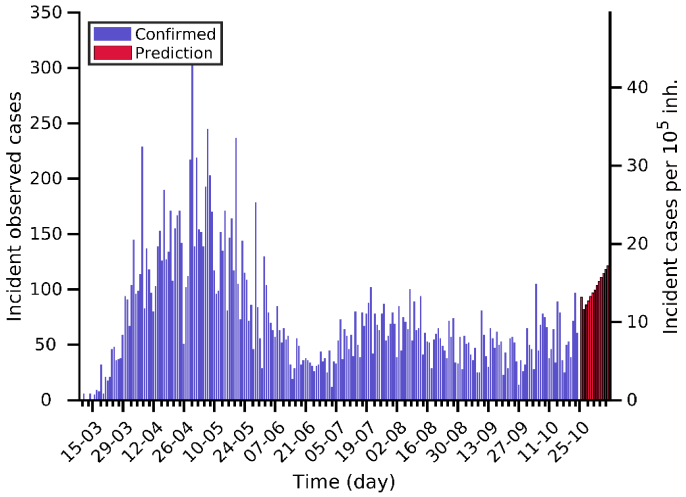


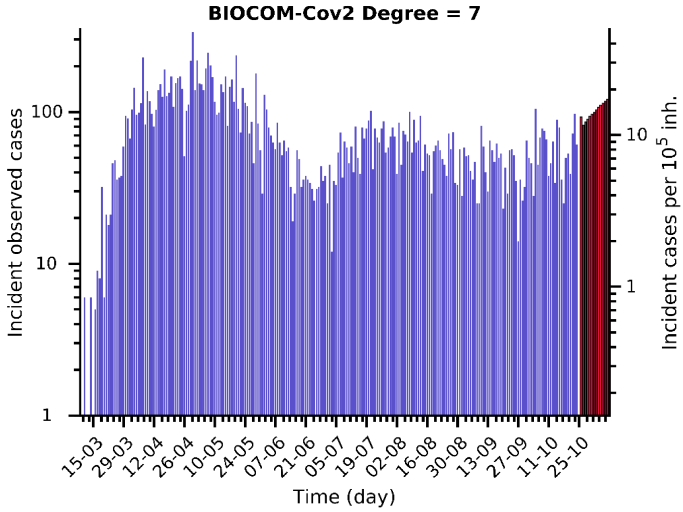
Predictions for next days

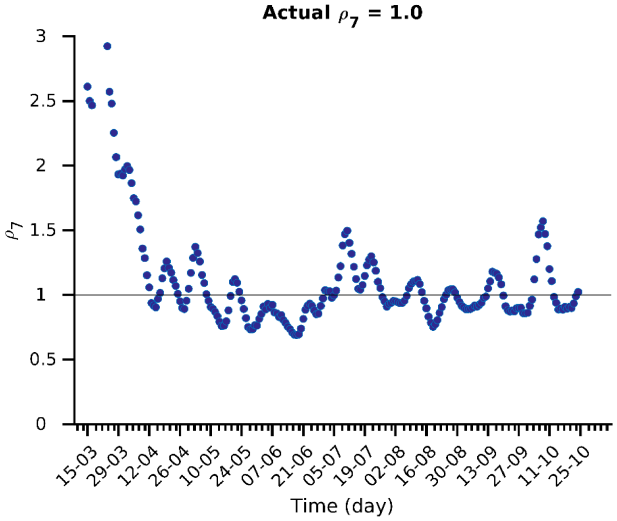
Day	Number of cases
26-10-2020	16860 (+93)
28-10-2020	17028 (+86)
30-10-2020	17211 (+94)

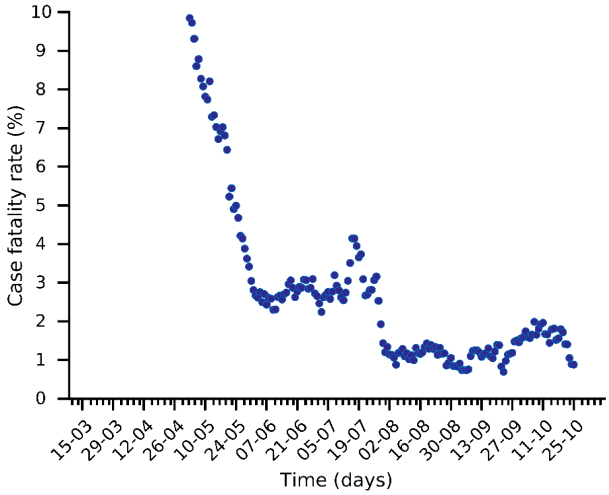
Current indicators

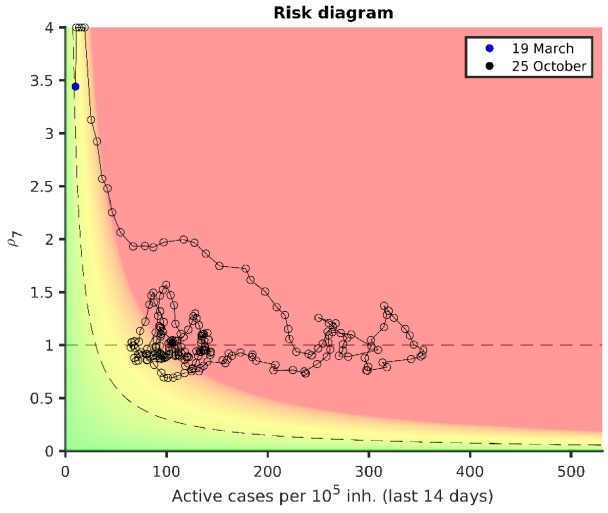
A_{14}	EPG	CFR
106	108	0.88 %

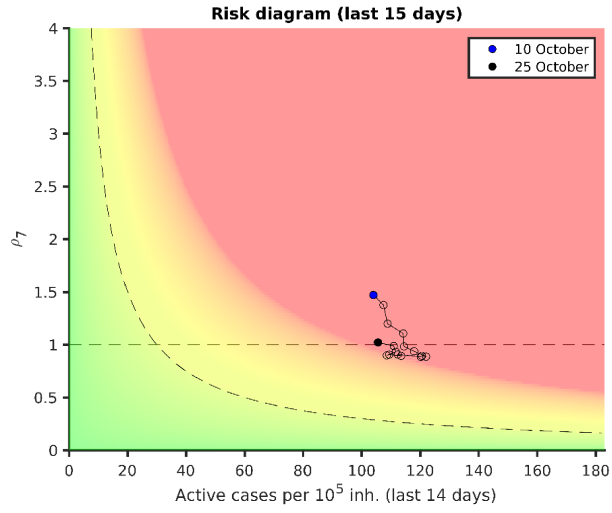




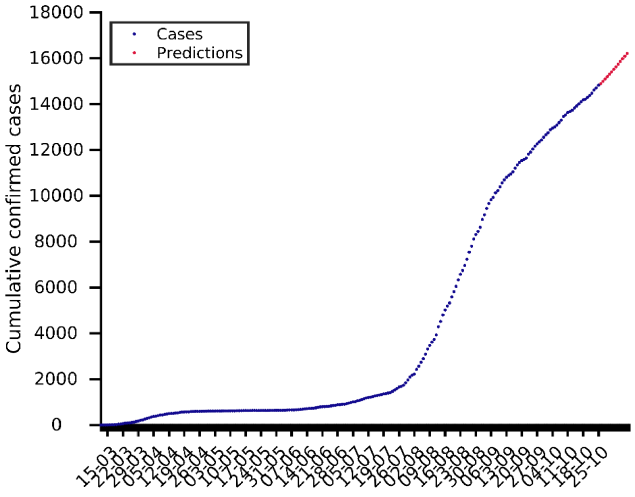








Hawaii 25-10-2020. Pop: 1.4M. Cumulative incidence: 1047/10⁵

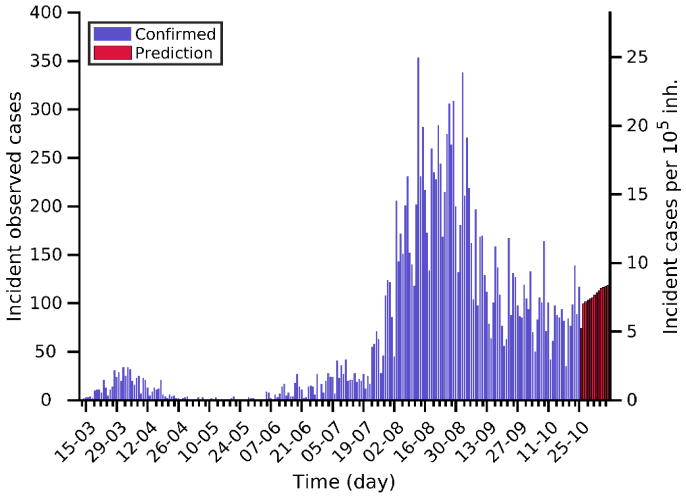


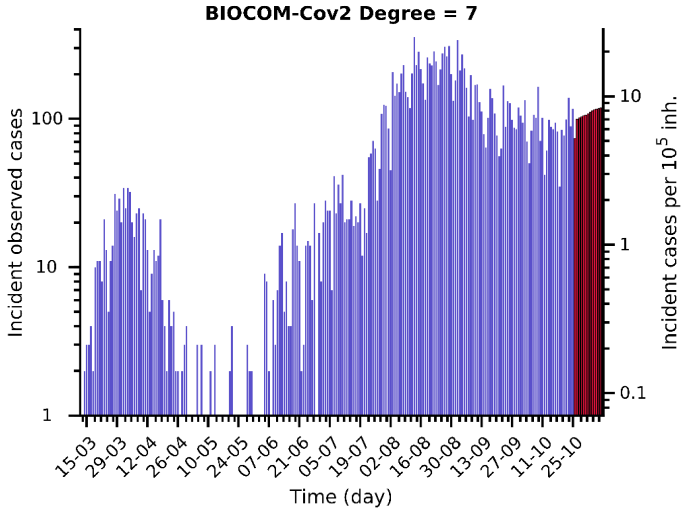
Predictions for next days

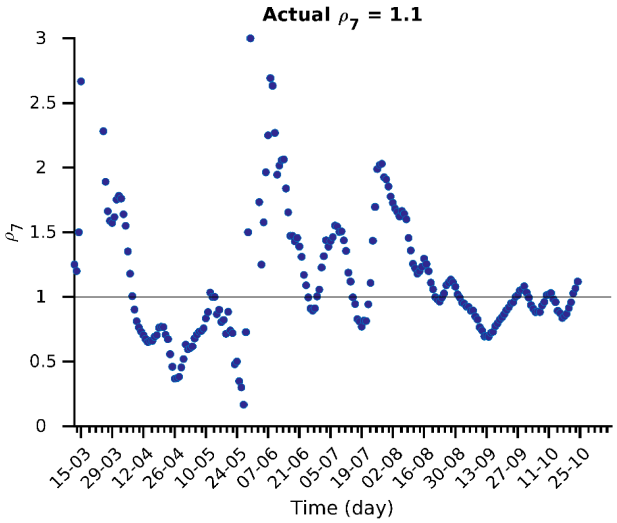
Day	Number of cases
26-10-2020	14897 (+74)
28-10-2020	15098 (+102)
30-10-2020	15306 (+105)

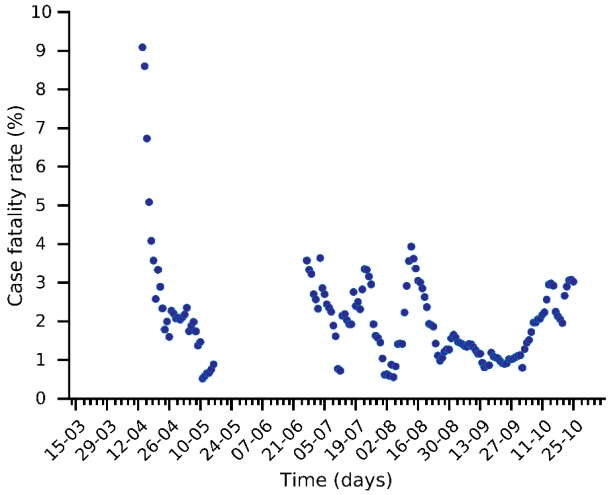
Current indicators

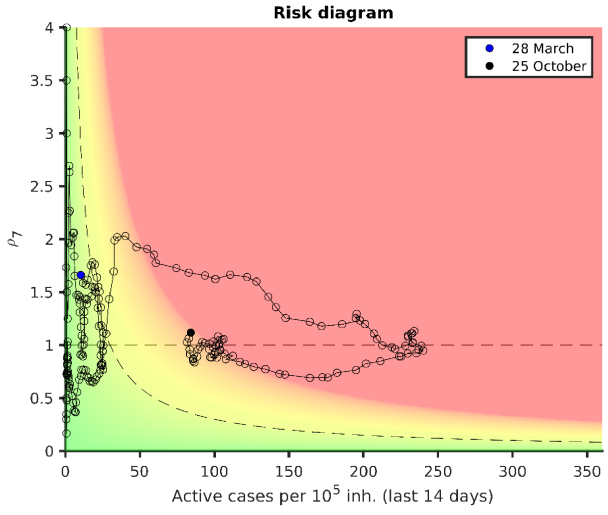
A_{14}	EPG	CFR
84	94	3.02 %

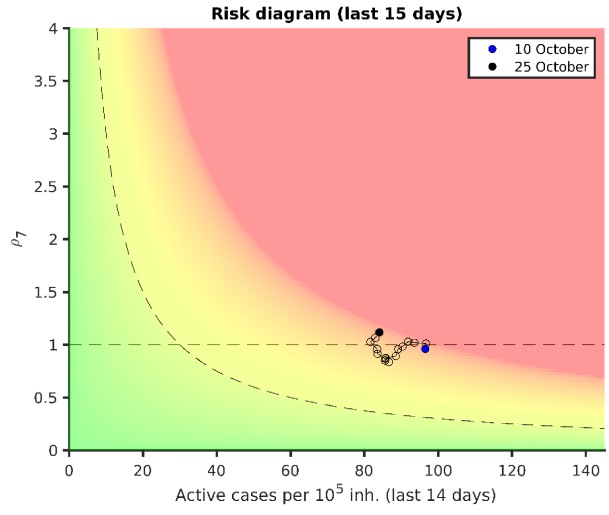




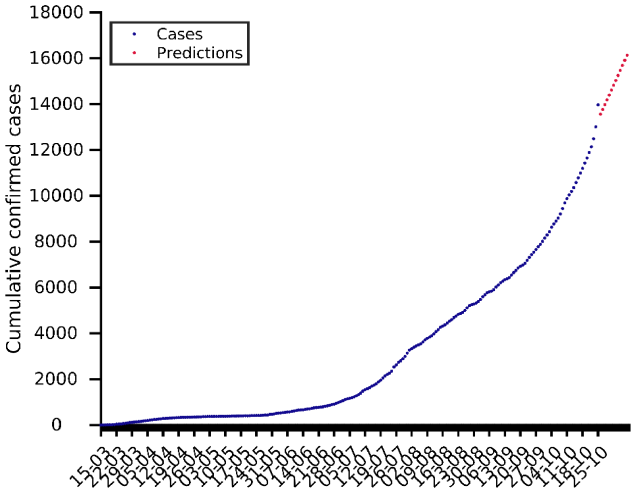








Alaska 25-10-2020. Pop: 0.7M. Cumulative incidence: 1909/10^5

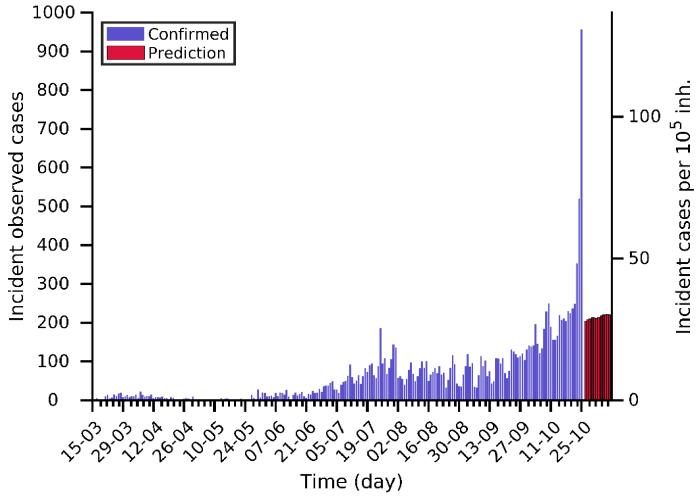


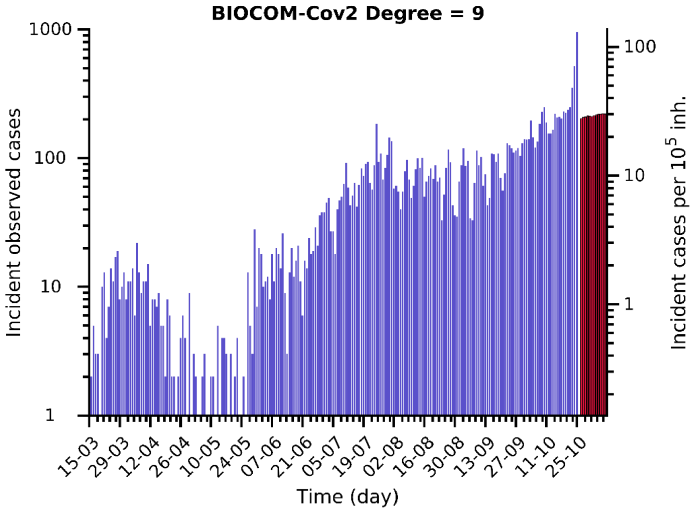
Predictions for next days

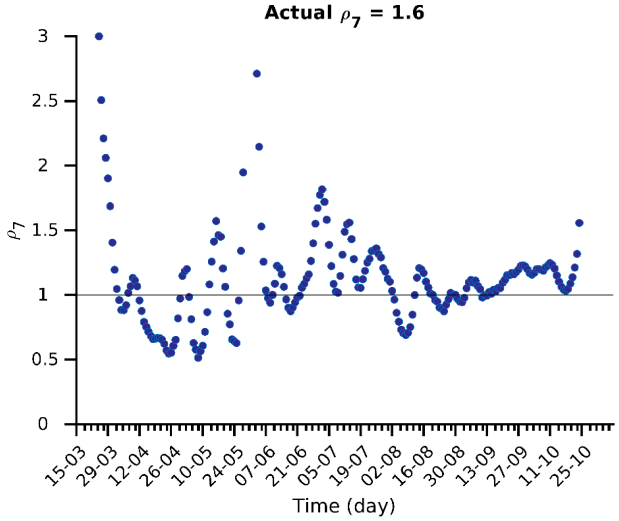
Day	Number of cases
26-10-2020	13566 (+-402)
28-10-2020	13976 (+207)
30-10-2020	14398 (+213)

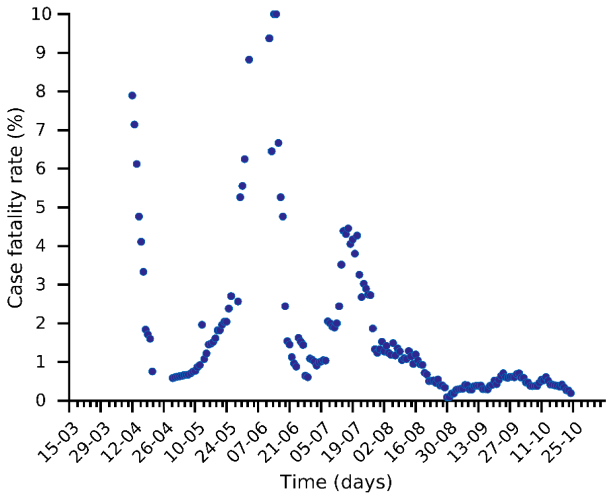
Current indicators

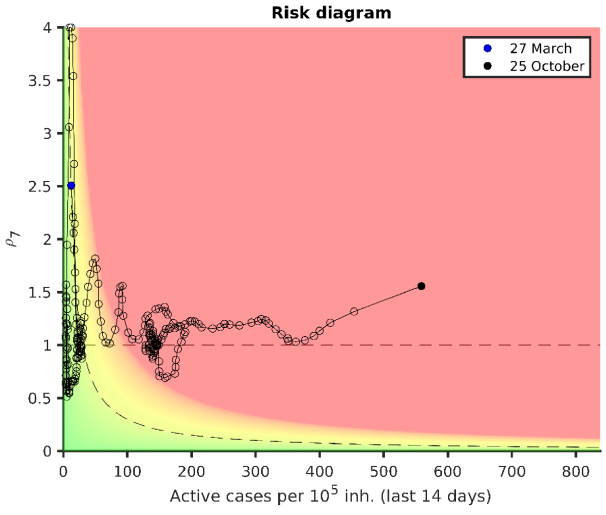
A_{14}	EPG	CFR
559	869	-0.12 %

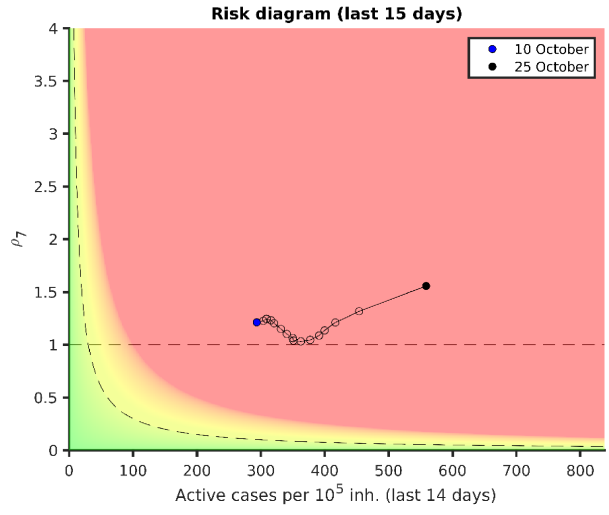




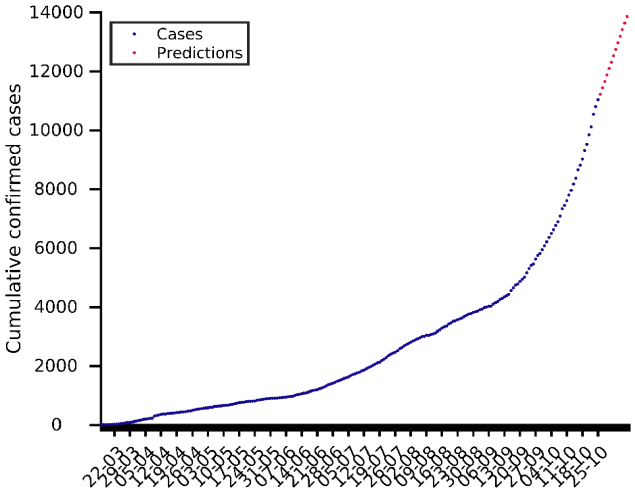








Wyoming 25-10-2020. Pop: 0.6M. Cumulative incidence: $1908/10^5$

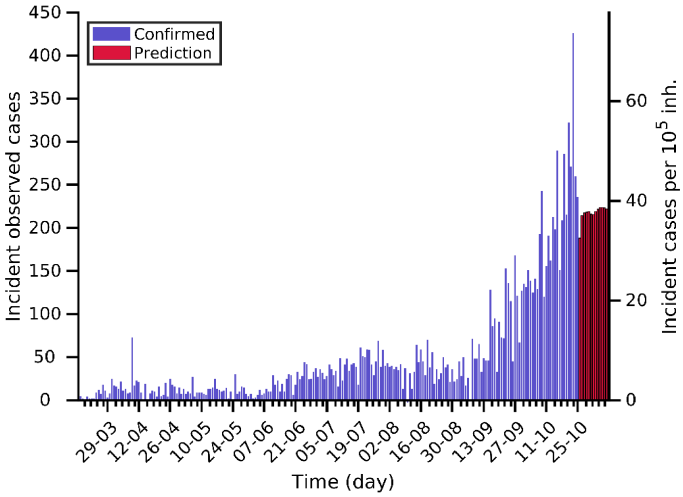


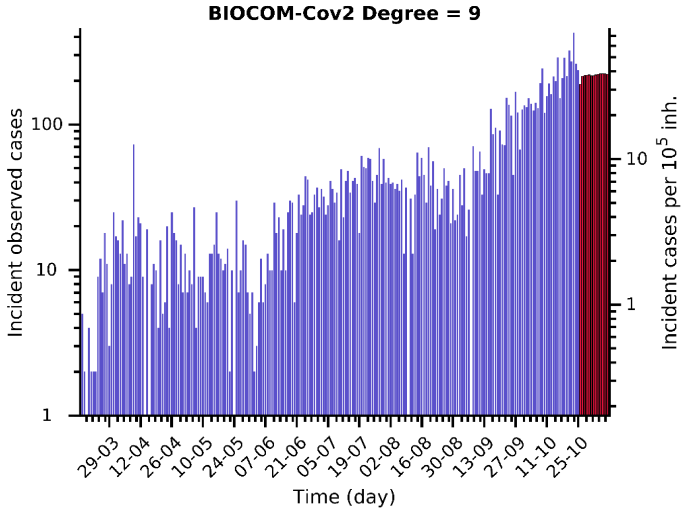
Predictions for next days

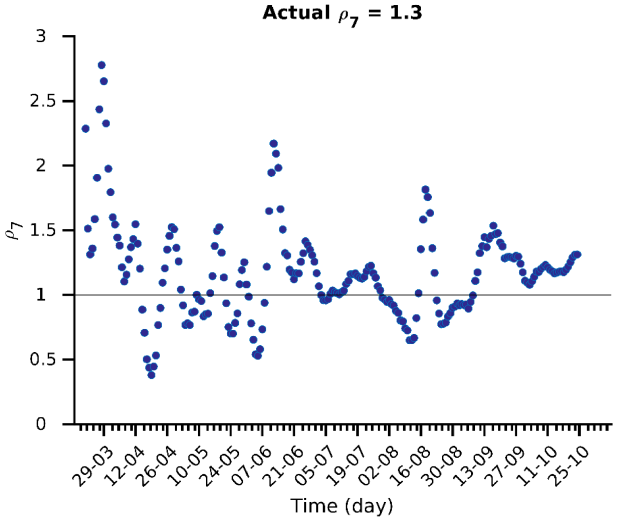
Day	Number of cases
26-10-2020	11229 (+188)
28-10-2020	11661 (+217)
30-10-2020	12098 (+219)

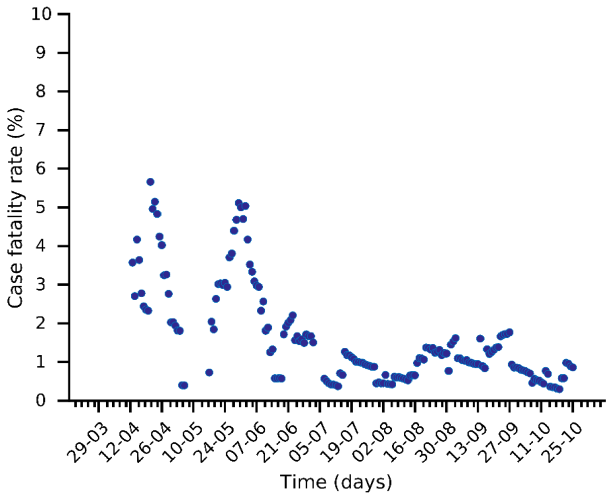
Current indicators

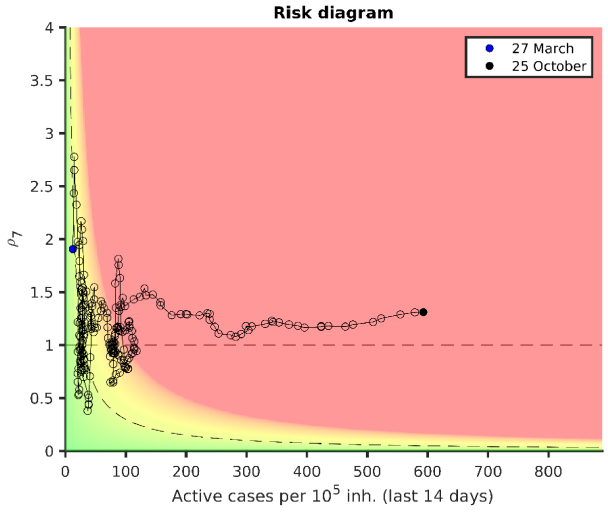
A_{14}	EPG	CFR
593	778	0.86 %

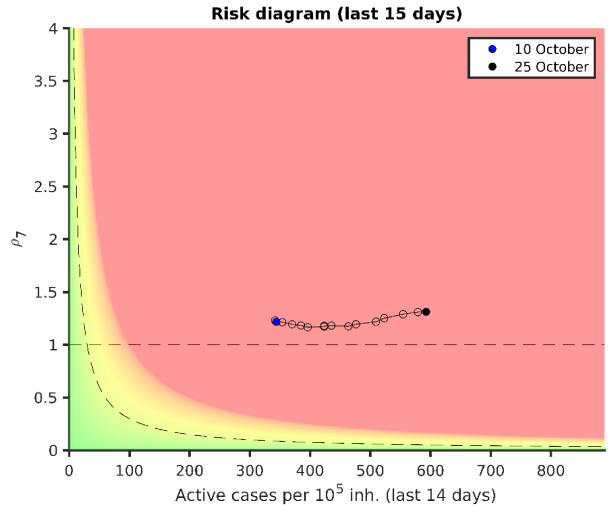




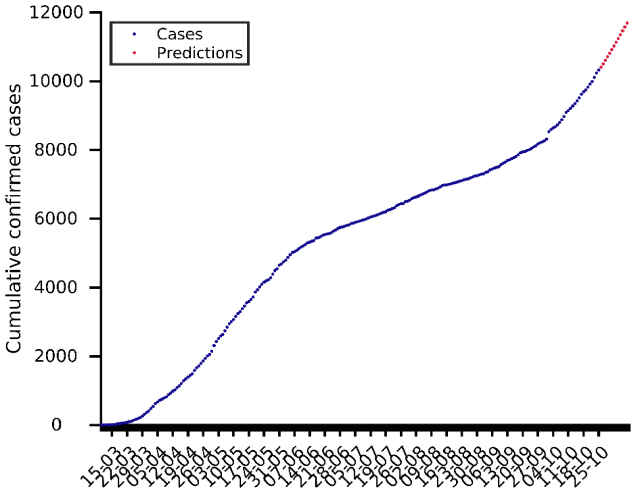








New Hampshire 25-10-2020. Pop: 1.4M. Cumulative incidence: 760/10⁵

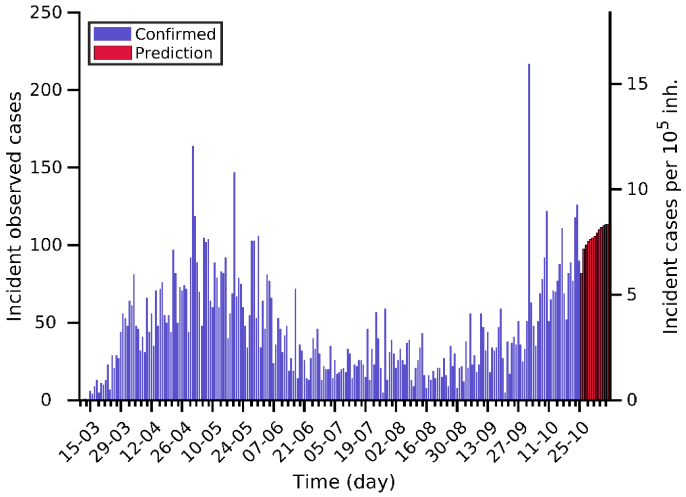


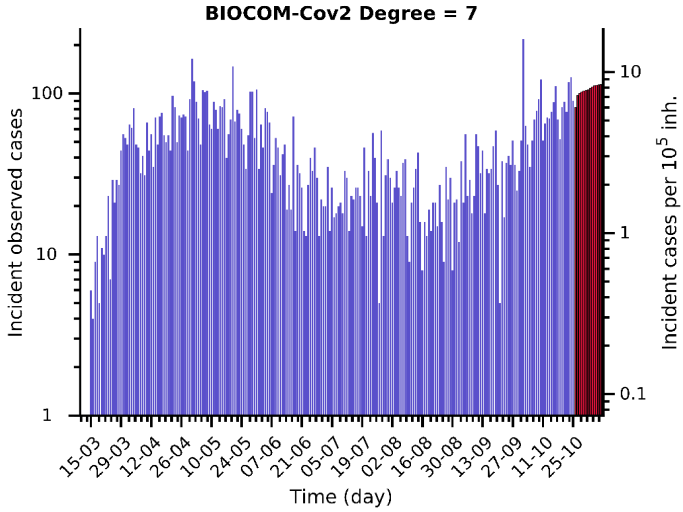
Predictions for next days

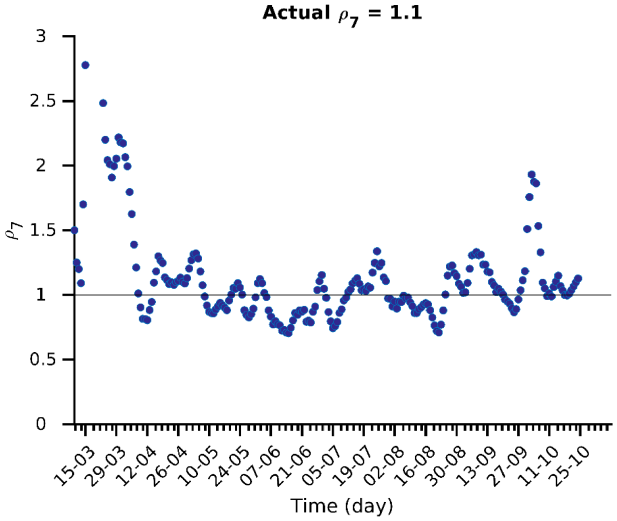
Day	Number of cases
26-10-2020	10410 (+82)
28-10-2020	10608 (+100)
30-10-2020	10814 (+104)

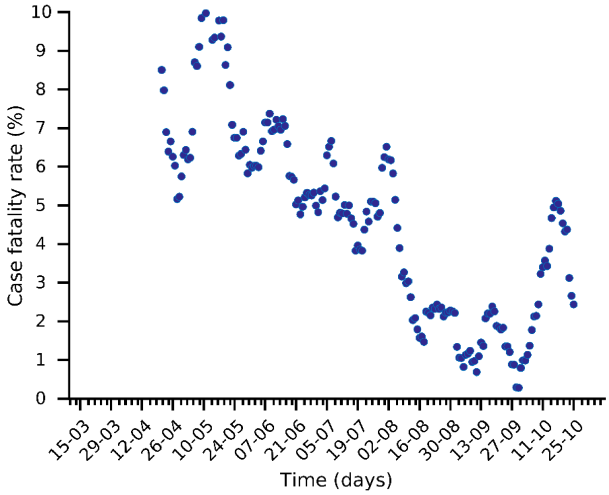
Current indicators

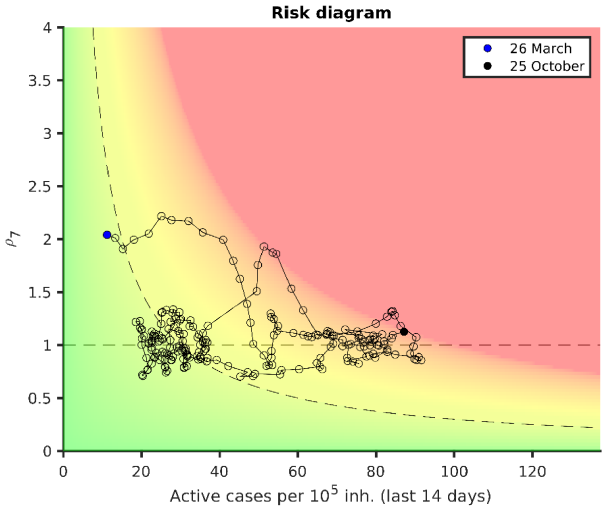
A_{14}	EPG	CFR
87	98	2.44 %

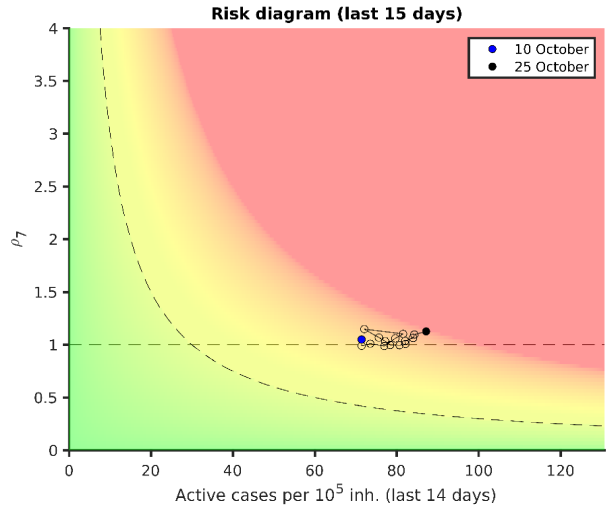




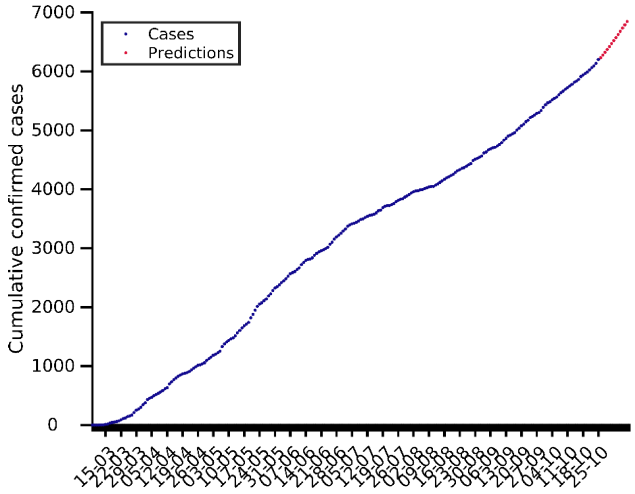








Maine 25-10-2020. Pop: 1.3M. Cumulative incidence: 461/10^5

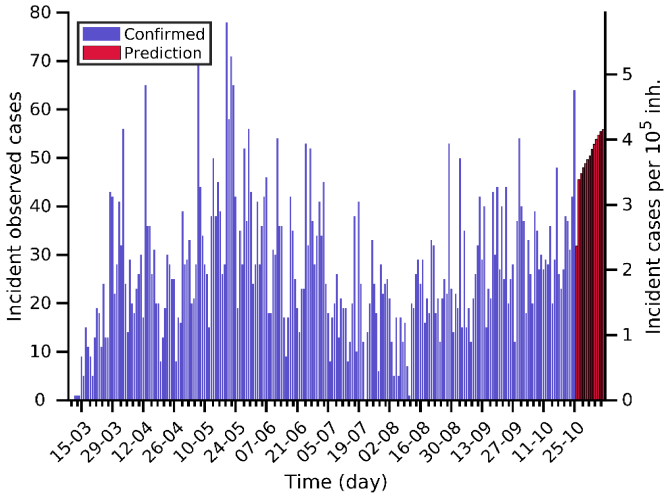


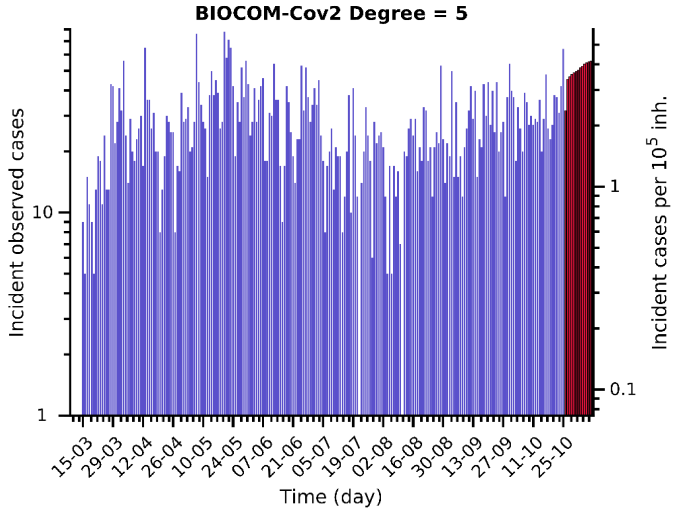
Predictions for next days

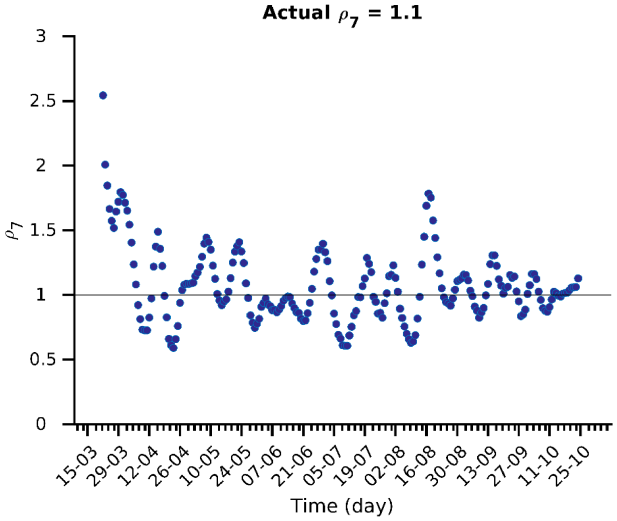
Day	Number of cases
26-10-2020	6233 (+32)
28-10-2020	6325 (+47)
30-10-2020	6422 (+49)

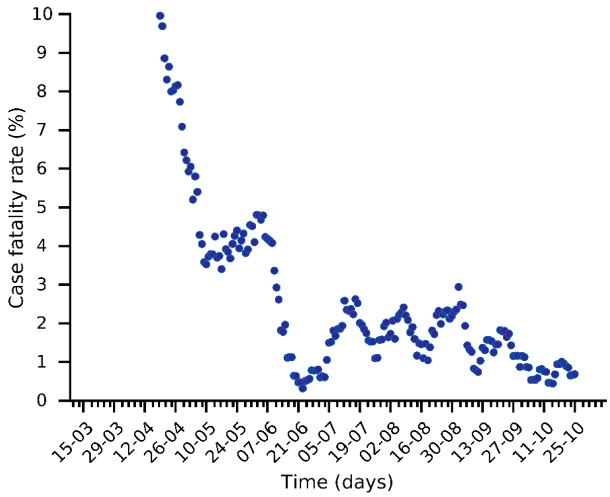
Current indicators

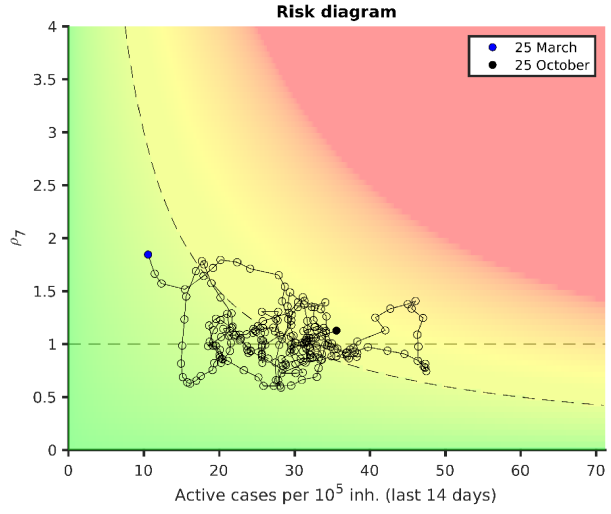
A_{14}	EPG	CFR
36	40	0.68 %

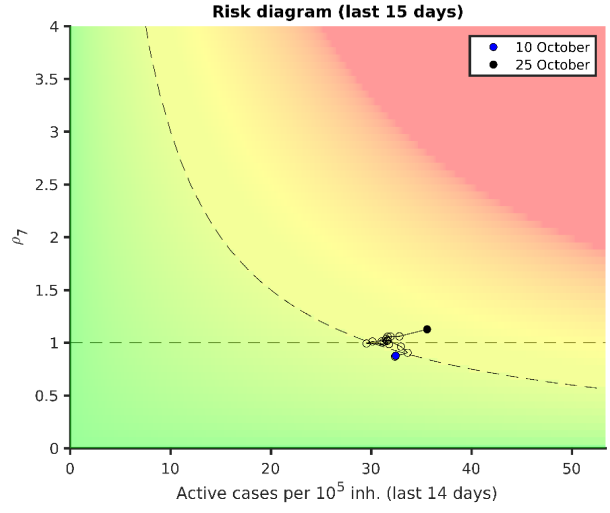




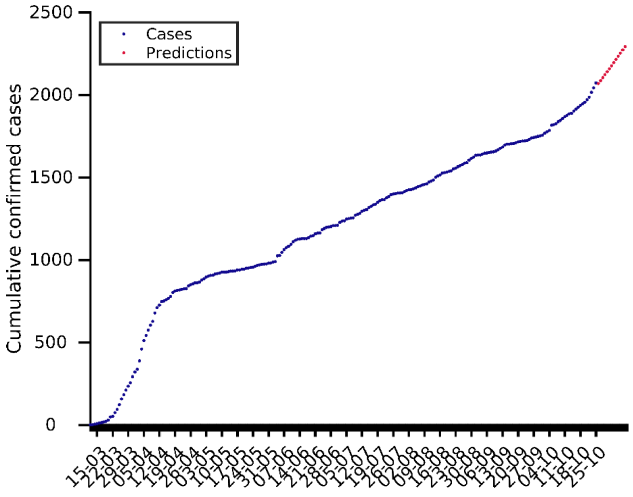








Vermont 25-10-2020. Pop: 0.6M. Cumulative incidence: 332/10⁵

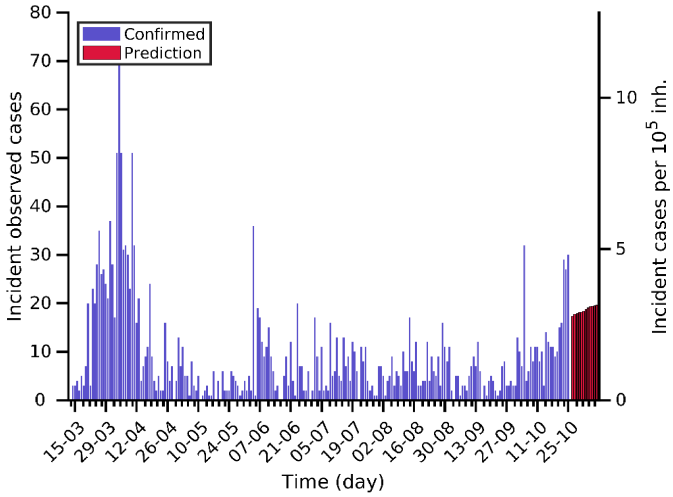


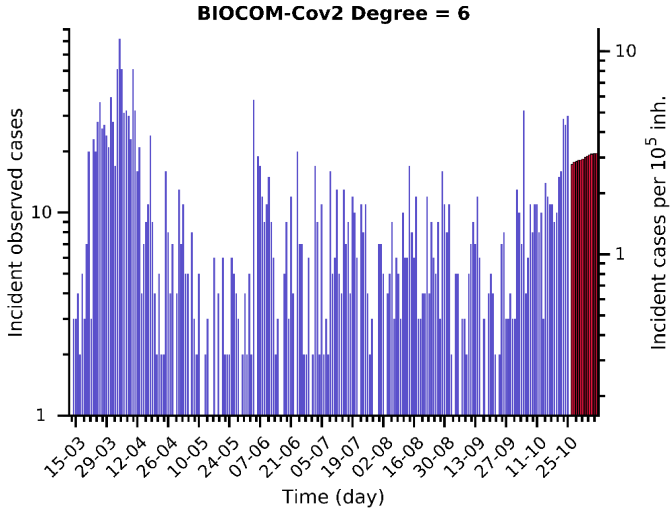
Predictions for next days

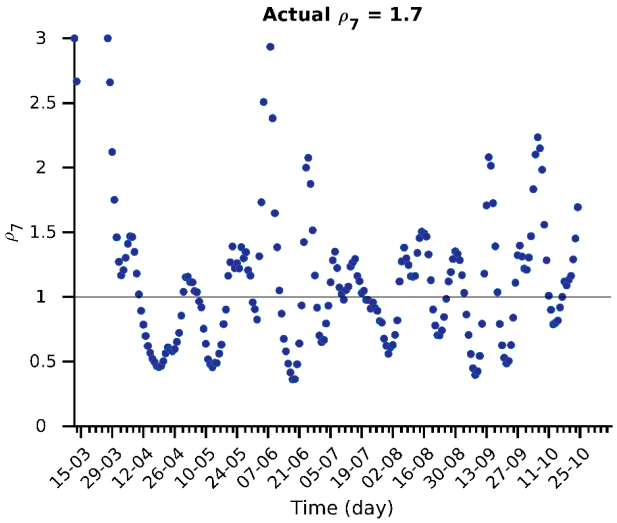
Day	Number of cases
26-10-2020	2070 (+-3)
28-10-2020	2105 (+18)
30-10-2020	2141 (+18)

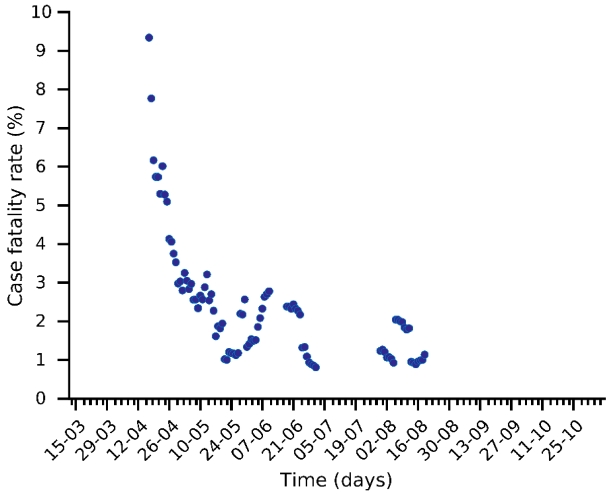
Current indicators

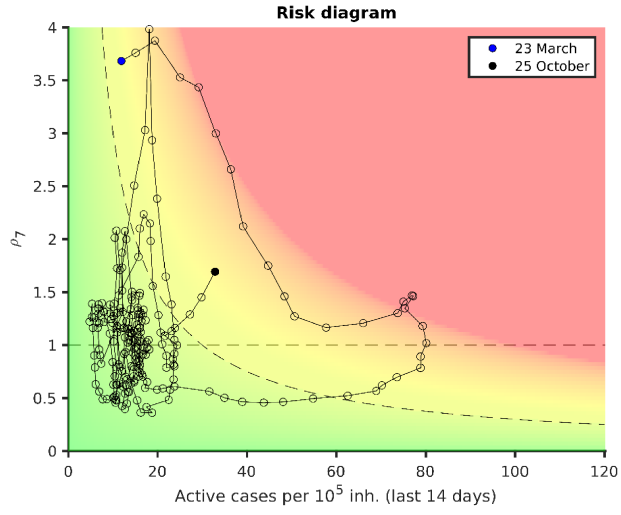
A_{14}	EPG	CFR
33	56	0.00 %

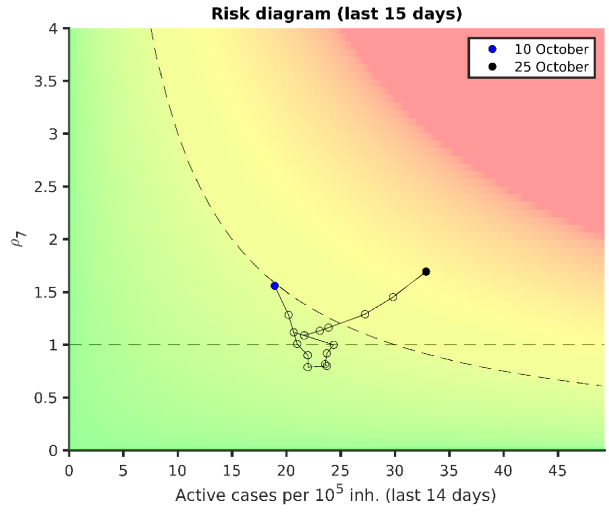












Methods

Methods

(1) Data source

Data are daily obtained from European Centre for Disease Prevention and Control (ECDC)[4] and country official sources (when indicated). Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

(2) Data processing and plotting

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for individual countries and for the UE+EFTA+UK as a whole:

- ✓ Number of cumulative confirmed cases
- ✓ Number of reported new cases
- ✓ Number of cumulative deaths

Then, two indicators are calculated and plotted, too:

- ✓ Case fatality rate: number of cumulative deaths divided by the number of cumulative confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
- ✓ ρ: this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report (*t-1*):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where $N_{new}(t)$ is the number of new confirmed cases at day *t* after applying a 7-day moving average to the new cases dataset, so that fluctuations (e.g., weekend effect) are smoothed.

(3) Classification of countries according to their epidemic level: the scale Biocom-Cov

Countries are assigned a degree in the discrete Biocom-Cov scale, which aims to facilitate a simple way of assessing the situation of the country. It is based on the level of daily new cases per 100,000 inhabitants as follows:

Pandemic degree	Daily new incident cases per 10^5 inh.
0	0
1	0-0.1
2	0.1-0.5
3	0.5-1.25
4	1.25-2
5	2-3
6	3-5
7	5-8
8	8-14
9	>14

[4] https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases

(4) Fitting a mathematical model to data

Previous studies have shown that Gompertz model[5] correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic wave that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied. Once in the tail, predictions work but the meaning of parameters is lost.

Gompertz model is described by the equation:

$$N(t) = K\, e^{-ln\left(\frac{K}{N_0}\right)\cdot e^{-a\cdot(t-t_0)}}$$

where *N(t)* is the cumulated number of confirmed cases at *t* (in days), and N_0 is the number of cumulated cases the day at day t_0. The model has two parameters:

- ✓ *a* is the velocity at which specific spreading rate is slowing down;
- ✓ *K* is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulative cases of the UE and of countries that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day t_0 is chosen as that one at which *N(t)* overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab's Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters (*a* and *K*) and the R^2 of the fitting. At the initial stages the dynamics is exponential and *K* cannot be correctly evaluated. In fact, at this stage the most relevant parameter is *a*.

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

(5) Using the model for predicting short-term tendencies

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases (3-5 days). The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bar. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

(6) Estimating non-diagnosed cases

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors[6] in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly

[5] Madden LV. Quantification of disease progression. Protection Ecology 1980; **2**: 159-176.
[6] Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3

due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.